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INHERITANCE OF BLACK HAIR PATTERNS IN CATTLE LACKING THE EXTENSION FACTOR FOR BLACK (E). III. A MULTIPLE ALLELIC HYPOTHESIS TO EXPLAIN THE INHERITANCE OF BLACKISH AND BLACKISH PATTERN[1]

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INTRODUCTION

Baldwin *et al.* (1954, 1956) have defined the terms "blackish" and "blackish pattern" and have concluded that the gene for blackish is dominant to its allele, the nonblackish gene. With reference to blackish pattern, Baldwin *et al.* (1956) concluded that its expressivity depends on the presence of the blackish gene. Further, they confirmed that blackish pattern is sex-influenced, the gene for blackish pattern acting as a dominant to its allele for blackish (nonpattern) in the male and as a recessive in the female. From their study, Baldwin *et al.* (1954, 1956) suggested that there are two loci involved in the inheritance of blackish and blackish pattern.

In the present paper an alternative hypothesis involving only one locus will be tested. This locus has three alleles, *viz.*, the genes for blackish pattern, blackish, and nonblackish. The nonblackish gene is assumed to be recessive to the gene for blackish and also to the gene for blackish pattern. The blackish pattern gene is again assumed to be sex-influenced, being dominant to the gene for blackish in the male and recessive to it in the female. The symbols adopted for the genes are as follows: Bs_M, blackish pattern; *Bs*, blackish; and *bs*, nonblackish. The terminology is similar to that suggested by Baldwin *et al.* (1954, 1956). The lower case letter *b* in *bs* is used because this gene is completely recessive to the other two alleles; the subscript *M* in Bs_M is used because this gene is dominant to *Bs* in the male and recessive in the female. In the female it is assumed that the homozygous state of the blackish pattern gene is expressed phenotypically as blackish pattern while the heterozygous condition is expressed as blackish. The phenotypes of the various genotypes are shown in table 1.

EXPERIMENTAL PROCEDURE AND RESULTS

In order to test this hypothesis on a given sample, it is necessary to develop a method of statistical analysis. If a given population is panmictic with respect to the colors involved and if there are no gene interactions with other loci, we may use the method of maximum likelihood to obtain estimates of gene frequency from

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a random sample and to test the hypothesis outlined above. General descriptions of the maximum likelihood method are presented in Mather (1951) and Hogben (1946).

TABLE 1

The phenotypes of the genotypes of the blackish allelic series

Genotype	Phenotype	
	Male	Female
$Bs_M\ Bs_M$	blackish pattern	blackish pattern
$Bs_M\ Bs$	blackish pattern	blackish
$Bs_M\ bs$	blackish pattern	blackish
$Bs\ Bs$	blackish	blackish
$Bs\ bs$	blackish	blackish
$bs\ bs$	nonblackish	nonblackish

Development of Formulae

In order to apply the maximum likelihood method of estimation to gene frequencies of the present problem, let,

a_1 = the observed number of blackish pattern males,
a_2 = the observed number of blackish males,
a_3 = the observed number of nonblackish males,
a_4 = the observed number of blackish pattern females,
a_5 = the observed number of blackish females,
a_6 = the observed number of nonblackish females,
i = 1, 2, 3, 4, 5, 6 classes,
$n = a_1+a_2+a_3+a_4+a_5+a_6$, the total number of individuals,
$m = (a_1+a_2+a_3)/n$, the proportion of males in the sample,
$1-m = (a_4+a_5+a_6)/n$, the proportion of females in the sample,
p = the true frequency of Bs_M,
q = the true frequency of Bs,
r = the true frequency of bs,
(Note that $p+q+r=1$.)
$\hat{p}$ = the maximum likelihood estimate of p,
$\hat{q}$ = the maximum likelihood estimate of q,
$\hat{r}$ = the maximum likelihood estimate of r,
f_i = the probability associated with the ith class,
nf_i = the expected number of individuals in the ith class.

Table 2 shows symbolically the observed numbers and probabilities for the six classes.

TABLE 2

Algebraic symbols for observed numbers and probabilities

Class i	Observed number a_i	Probability f_i
1 (blackish pattern males)	a_1	$m\ (p^2+2pq+2pr)$
2 (blackish males)	a_2	$m\ (q^2+2qr)$
3 (nonblackish males)	a_3	$m\ (r^2)$
4 (blackish pattern females)	a_4	$(1-m)\ (p^2)$
5 (blackish females)	a_5	$(1-m)\ (2pq+2pr+q^2+2qr)$
6 (nonblackish females)	a_6	$(1-m)\ (r^2)$

Then, the exact probability π of obtaining the observed sample is,

$$\pi = \frac{n!}{a_1!a_2!a_3!a_4!a_5!a_6!}(p^2+2pq+2pr)^{a_1}(q^2+2qr)^{a_2}(r^2)^{a_3}(p^2)^{a_4} (2pq+2pr+q^2+2qr)^{a_5}(r^2)^{a_6}m^{(a_1+a_2+a_3)} (1-m)^{(a_4+a_5+a_6)}.$$

A simplified logarithmic likelihood expression L may be derived from π by factoring, by using the relationship $(p+q+r)^2=1$, and by omitting constants:

$$L = a_1 \log p + a_1 \log (p+2q+2r) + a_2 \log q + a_2 \log (q+2r) + 2a_3 \log r + 2a_4 \log p + a_5 \log (1-p^2-r^2) + 2a_6 \log r.$$

The maximum likelihood method requires that L be maximized, by taking the partial derivatives of L with respect to p, q, and r, setting the resulting three equations equal to zero, and solving them simultaneously for $\hat{p}$, $\hat{q}$, and $\hat{r}$. In the present problem the variables are mutually dependent under the restriction

$$p+q+r=1,$$

such that the partial derivatives of L with respect to each of the three variables become complicated. The method of Lagrange multipliers provides a tool for solving such a system. A discussion of this method may be found in Widder (1947), page 113.

By the method of Lagrange, we introduce the Lagrange multiplier λ and form a new function V, where,

$$V = L+\lambda(p+q+r-1).$$

Then we may treat p, q, and r as if they were independent variables and we set

$$\frac{\partial V}{\partial p} = \frac{\partial L}{\partial p}+\lambda = 0$$

$$\frac{\partial V}{\partial q} = \frac{\partial L}{\partial q}+\lambda = 0$$

$$\frac{\partial V}{\partial r} = \frac{\partial L}{\partial r}+\lambda = 0.$$

We may solve this system of equations simultaneously with

$$p+q+r-1=0.$$

We will thus obtain values of λ, p, q, and r. The estimates of p, q, and r will be the maximum likelihood estimates $\hat{p}$, $\hat{q}$, and $\hat{r}$, which we seek. Since we are interested in λ only as a tool, we may discard it.

Following the plan outlined above, we obtain the equations,

$$\frac{\partial V}{\partial p} = \frac{a_1}{p} + \frac{a_1}{p+2q+2r} + \frac{2a_4}{p} - \frac{2a_5 p}{1-p^2-r^2}+\lambda = 0 \quad (1)$$

$$\frac{\partial V}{\partial q} = \frac{2a_1}{p+2q+2r} + \frac{a_2}{q} + \frac{a_2}{q+2r}+\lambda = 0 \quad (2)$$

$$\frac{\partial V}{\partial r} = \frac{2a_1}{p+2q+2r} + \frac{2a_2}{q+2r} + \frac{2a_3}{r} - \frac{2ra_5}{1-p^2-r^2} + \frac{2a_6}{r}+\lambda = 0 \quad (3)$$

$$p+q+r=1. \quad (4)$$

Eliminating q by substituting $q=1-p-r$, we obtain

$$\frac{a_1}{2-p} + \frac{a_1+2a_4}{p} - \frac{2a_5 p}{1-p^2-r^2}+\lambda = 0 \quad (5)$$

$$\frac{2a_1}{2-p} + \frac{a_2}{1-p-r} + \frac{a_2}{1-p+r}+\lambda = 0 \quad (6)$$

$$\frac{2a_1}{2-p}+\frac{2a_3+2a_6}{r}-\frac{2a_5r}{1-p^2-r^2}+\frac{2a_2}{1-p+r}+\lambda=0 \tag{7}$$

(7) minus (6) produces the equation,

$$\frac{2a_3+2a_6}{r}-\frac{2a_5r}{1-p^2-r^2}-\frac{a_2}{1-p-r}+\frac{a_2}{1-p+r}=0 \tag{8}$$

and (5) minus (6) gives,

$$\frac{a_1+2a_4}{p}-\frac{a_1}{2-p}-\frac{2a_5p}{1-p^2-r^2}-\frac{a_2}{1-p-r}-\frac{a_2}{1-p+r}=0. \tag{9}$$

By eliminating fractions in (8) and (9), we may obtain equations of estimation of p and r:

$$(a_2+a_3+a_5+a_6)r^4-(a_2+2a_3+a_5+2a_6)r^2+(a_2-a_5)r^2p^2+2(a_3+a_5+a_6)r^2p$$
$$-(a_3+a_6)p^4+2(a_3+a_6)p^3-2(a_3+a_6)p+(a_3+a_6)=0 \tag{10}$$

and,

$$(a_1+2a_4)+(a_1+2a_4)r^4-2(a_1+2a_4)r^2-(a_1+a_4)r^4p+2(2a_1+a_2+3a_4)r^2p$$
$$-(2a_1+3a_2+2a_4-2a_5)r^2p^2+(a_2-a_5)r^2p^3-(3a_1+2a_2+5a_4)p$$
$$+(2a_1+3a_2+2a_4-2a_5)p^2+(2a_1+a_2+4a_4+5a_5)p^3-(3a_1+3a_2+4a_4+4a_5)p^4$$
$$+(a_1+a_2+a_4+a_5)p^5=0. \tag{11}$$

Since there exists no easy algebraic approach to the simultaneous solution of these two equations, they may be solved for any specific example by iteration. A discussion of this iterative method will appear in the examples of the subsequent section.

Test of Hypothesis

The data used to test the hypothesis in this study are those of Baldwin *et al.* (1954, 1956). Only males of 1 year of age and above and females of 2 years of age and above were used. Animals carrying much white (*lw lw*) were omitted because the presence or absence of the blackish pattern on such animals could not be determined. The animals used in this study were 229 Jerseys (61 males and 168 females) and 372 Ayrshires (66 males and 306 females). The numbers in each of the 6 phenotypic classes are indicated in table 3.

TABLE 3

Observed phenotypic frequencies of Jerseys and Ayrshires

Phenotype	Jerseys	Ayrshires
Blackish pattern males	46	36
Blackish males	14	23
Nonblackish males	1	7
Blackish pattern females	50	51
Blackish females	112	200
Nonblackish females	6	55

Jersey data.—By formulae (10) and (11) the two equations of estimation of p and r for the Jersey case are,

$$f(p,r)=133\ r^4-140\ r^2-98\ r^2p^2+238\ r^2p-7p^4+14p^3-14p+7=0 \tag{12}$$

and,

$$g(p,r)=146+146\ r^4-292\ r^2-96\ r^4p+512\ r^2p-10\ r^2p^2-98\ r^2p^3-416\ p$$
$$+10\ p^2+866\ p^3-828\ p^4+222\ p^5=0. \tag{13}$$

Since there is no easy algebraic method of solution, these equations must be solved simultaneously by iteration. This method involves successive approximations of p and r, until the values of $f(p,r)$ and $g(p,r)$ become as close to zero as the desired degree of accuracy. Three decimal accuracy was chosen in the present problem.

In the Jersey case the value of r was narrowed to the range .171 to .173; and p, to the range .531 to .533. Table 4 represents the values of $f(p,r)$ and $g(p,r)$ under the various combinations of p and r in the above ranges.

The best simultaneous solution of the two equations is $p=.532$ and $r=.172$; therefore, these values are designated as the maximum likelihood estimates $\hat{p}$ and $\hat{r}$. Through the relationship $\hat{q}=1-\hat{p}-\hat{r}$, we obtain $\hat{q}=.296$. It will be noted that $\hat{r}$ does not differ appreciably from the value of .19 found by the method of Baldwin *et al.* (1954).

From $\hat{p}$, $\hat{q}$, and $\hat{r}$ theoretically expected phenotypic frequencies may be computed by means of the f_i defined in table 2. Table 5 presents observed and calculated numbers for the six phenotypes.

TABLE 4

Values of f(p,r) *and* g(p,r) *corresponding to approximations for* p *and* r

p	r	$f(p,r)$	$g(p,r)$
.531	.171	.013	.107
.532	.171	.011	.039
.533	.171	.008	−.029
.531	.172	.001	.096
.532	.172	−.001	.029
.533	.172	−.003	−.039
.531	.173	−.010	.085
.532	.173	−.012	.018
.533	.173	−.015	−.050

TABLE 5

Quantities from Jersey data necessary for calculation of χ^2

Class i		Observed number a_i	Calculated number nf_i
1	(blackish pattern males)	46	47.572
2	(blackish males)	14	11.540
3	(nonblackish males)	1	1.802
4	(blackish pattern females)	50	47.572
5	(blackish females)	112	115.541
6	(nonblackish females)	6	4.973

The calculated frequencies were compared with the observed frequencies by the chi-square test. In the Jersey case the calculated numbers in classes 3 and 6 are so small that the two classes were combined for purposes of χ^2 calculation; therefore, we must consider that we have only five classes. Since two of the gene frequencies were calculated independently (the third by difference from 1), the degrees of freedom appropriate to the chi-square test are the number of classes minus the number of independent parameters estimated from the data minus

1, *i.e.*, $5-2-1=2$. The chi-square value for the Jerseys is .816 for 2 degrees of freedom with a probability of about 96%, indicating that the suggested hypothesis fits the data very well.

Ayrshire data.—The Ayrshire data in table 3 lead to equations of estimation (14) and (15):

$$f(p,r)=285\,r^4-347\,r^2-177\,r^2p^2+524\,r^2p-62\,p^4+124\,p^3-124\,p+62=0 \quad (14)$$

and,

$$g(p,r)=138+138\,r^4-276\,r^2-87\,r^4p+496\,r^2p+157\,r^2p^2-177\,r^2p^3-409\,p \\ -157\,p^2+1299\,p^3-1181\,p^4+310\,p^5=0. \quad (15)$$

Solution of these equations gives $\hat{p}=.378$ and $\hat{r}=.400$; therefore, $\hat{q}=.222$. It will be noted that the value for $\hat{r}$ is similar to the corresponding value of .42 found by Baldwin *et al.* (1954). Observed and calculated frequencies necessary for calculation of χ^2 are presented in table 6.

TABLE 6

Quantities necessary for calculation of χ^2 *for Ayrshire case*

Class i	Observed numbers a_i	Calculated numbers nf_i
1	36	40.370
2	23	14.939
3	7	10.535
4	51	43.745
5	200	213.426
6	55	48.985

In this case $\chi^2=8.795$ with 3 degrees of freedom. The suggested hypothesis is therefore rejected at the 5 percent level of significance but accepted at the 2 percent level.

DISCUSSION

The above analysis has shown that the proposed hypothesis of gene expression is accepted in the Jersey case but is rejected at the 5 percent level in the Ayrshire case. If the genes are the same in the two breeds, an assumption which seems reasonable, the results are inconclusive regarding the validity of the hypothesis. This may be due to the fact that either or both of the sexes in either or both of the breeds are not random samples of the population in question. Further samples might help to elucidate this point. There is also the possibility of non-random mating, but as far as is known, there is no discrimination for or against blackish pattern or blackish.

The results of matings could also distinguish between the present hypothesis and that of Baldwin *et al.* (1954, 1956). If a mating between a blackish bull and a nonblackish cow produced a male blackish pattern offspring, then the multiple allelic hypothesis would be rejected; since, under this hypothesis, the bull would be either *BsBs* or *Bsbs* and the cow *bsbs*, no blackish pattern offspring could result from this mating. Under the hypothesis of Baldwin and his associates the cow could be $bsbs\ Bp_M-$; when mated with a blackish bull $Bs-\ BpBp$ she could produce a blackish pattern male ($BsBs\ Bp_MBp$). Another distinguishing mating could be a blackish pattern cow with a nonblackish bull. By the multiple allelic hypothesis only blackish pattern male offspring and blackish female offspring

can result. On the other hand, under the hypothesis of Baldwin *et al.* (1954) males may be blackish pattern or nonblackish, while females may be of all three phenotypes. Such matings might be undertaken to test the multiple allelic hypothesis.

Progeny resulting from matings of the two kinds suggested have not been observed for two reasons: 1) The data used for the calculations in this paper were collected by Baldwin *et al.* (1954, 1956) for a different purpose and did not include information on mating structure; 2) these matings occur relatively infrequently and therefore resulting progeny are quite scarce.

SUMMARY AND CONCLUSIONS

A multiple allelic hypothesis is suggested to explain the inheritance of blackish and blackish pattern in Jersey and Ayrshire cattle. The three alleles are blackish pattern (Bs_M), blackish (Bs) and nonblackish (bs). Blackish pattern is sex-influenced.

Sample data were used to test this hypothesis. The hypothesis was accepted—with a high degree of probability—in the Jersey data but was rejected at the 5 percent level of significance in the Ayrshire data. The results for the two breeds are conflicting and are inconclusive regarding the validity of the hypothesis. Matings are suggested for further testing this hypothesis.

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Atomic Energy in Medicine. *K. E. Halnan,* M. D. Philosophical Library, Inc., New York. First edition, 1957. ix+157 pp. $6.00.

This delightfully readable volume provides an excellent survey of the uses of atomic energy in the medical field. The first chapter, "Introduction to Atomic Physics and the Nuclear Reactor," is especially valuable in that it is short, concise and requires only minimal knowledge of chemistry, physics and mathematics for adequate understanding and introduction to what follows. The subsequent chapters deal with the biologic effects of ionizing radiations and the medical diagnostic and therapeutic uses of the various radioactive isotopes and high energy particle accelerators. Since this book is written by a Britisher, it naturally emphasizes the uses and experience with which the author is most familiar. This does not detract from its usefulness, but indeed, makes it of additional value to the American reader.

Particularly apropos of the present concern about radiation exposure from medical uses of x-ray and isotopes is Chapter 10, "The Problems and Hazards of Radiation." This subject is dealt with in a factual way devoid of the emotionalism of most articles presently available for public consumption. The author concludes with a brief prediction for the future of medicine in the atomic age and describes the character of the hospital to be built in 1984.

There is no detailed bibliography; however, the author has appended a list of articles and books suggested for further reading on the subject. This book should prove of most interest and value to those individuals engaged in scientific disciplines, whether closely or remotely allied to medicine, who wish an introductory survey of the many and varied peaceful uses of atomic energy in attempting better to alleviate human suffering. Also, those engaged directly in this particular field will find much of value here, especially if they are called upon to lecture to lay audiences and find difficulty in simplifying their discussion for ease of communication.

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AN ADJUSTABLE CAPILLARY METHOD FOR THE DETERMINATION OF SURFACE TENSIONS

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The best standard method for determining the surface tension of a liquid is the capillary rise method. This method is capable of very good accuracy when suitable precautions are taken, but in practice it suffers from the fact that the calibration of the capillary diameter is tedious and requires a traveling microscope.

The purpose of this paper is to describe a method of calibration which is simple, rapid, and gives excellent results. In its simplest application it gives results accurate within one-half percent, suitable for routine determinations or for physical chemistry laboratory, and with care should be useful as a highly accurate research method.

The capillary is given a permanent marking at some convenient height. The capillary is inserted into a pure liquid of known surface tension, and the equilibrium position of the capillary meniscus brought just to rest on the capillary marking. The meniscus is adjusted to this point by either of two ways: first, by getting an approximate adjustment just below the desired level by raising or lowering the capillary, and then adding liquid a drop at a time to the reservoir of liquid in the principal container or, second, by having the capillary mounted on a screw-driven trolley so that very fine vertical adjustments can be easily made by turning a knob. The height of the liquid column in the capillary can be accurately measured with a cathetometer.

From the capillary rise and the known value of the surface tension, the radius of the capillary is easily calculated. The capillary can then be used to determine the surface tensions of other liquids by adjusting the capillary to bring the meniscus to rest on the mark at which the capillary was calibrated with the reference liquid.

TABLE 1

Surface tension values by the adjustable capillary method

Compound	Literature	Cap 1	Cap 2	Cap 3	Cap 4	Cap 5
Benzene	28.88	28.81	28.86	28.85	28.90	28.86
Methanol	22.61	22.55	22.57	22.62	22.64	22.60
Toluene	28.50	28.47	28.56	28.51	28.38	28.50
Carbon Tetrachloride	26.95	26.90	26.96	26.97	27.01	26.93
Chloroform	27.14	27.13	27.10	27.10	27.14	27.17

Table 1 shows the method applied to several liquids for five different capillaries. Each was calibrated with acetone at 20° C. The reservoir in each case was a 200 ml test tube in a 20° C water bath. The capillary height was adjusted by hand. Readings of the capillary rise were made with a cathetometer.

The agreements shown in the table are excellent; yet the materials are inexpensive and the procedure easy. It seems to us that this method could be made adequate for research determinations by using a properly made reservoir and a capillary tube rigidly mounted on a raising device with a micrometer adjustment screw.

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A STUDY OF THE STERIC REQUIREMENTS OF THE 9–ANTHRACYL GROUP AND THEIR CONTRIBUTION TO THE PREPARATION OF 9–ANTHRACYLBORON COMPOUNDS

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The differences in the chemical behavior of certain trialkylboranes have been attributed to the steric requirements of the alkyl groups in the boron derivative (Brown, 1945). These irregularities are even more conspicuous when three large bulky aryl groups are attached to the boron atom. For example, the chemical activity of triphenylborane, tri-*a*-naphthylborane,[2] and trimesitylborane[2] has been found to decrease in that order (Brown and Dodson, 1957).

It was of interest to prepare tri-9-anthracylborane[2] and to compare its reactivity with that of TNB and TMB. An examination of the space models of the three triarylboranes shows that the boron atom is shielded by the surrounding aryl groups in the order TNB<TAB<TMB. Since most of the reactions of triarylboranes involve an attack on the boron-carbon bond, the chemical activity of the three compounds should be of the opposite order. Simplified line drawings of the three triarylboranes are shown in figure 1.

EXPERIMENTAL PROCEDURE

Since several triarylboranes have been prepared by the reaction of the aryl Grignard reagent with boron trifluoride, it seemed probable that this method could be applied to the synthesis of TAB. Commercial boron trifluoride-etherate, made by Eastman Kodak Co., was distilled in an all glass apparatus at reduced pressure and in an atomosphere of dry nitrogen. The water white portion boiling over the range 75 to 76°C at 73 mm Hg pressure was collected and stored in a glass stoppered receiver.

The method of Barnett and Cook (Shirley, 1951) was used to prepare 9-bromoanthracene. Anthracene was first converted to 9,10-dibromo- 9,10-dihydro-anthracene. This was dehydrohalogenated to form the desired 9-bromo derivative. The product melted over the range 99 to 100°C[3] after successive recrystallizations from ethanol and ligroin (b.p. 100 to 110°C).

The 9-anthracylmagnesium bromide Grignard reagent was prepared by reacting 9-bromoanthracene with purified magnesium in anhydrous diethyl ether. Five drops of ethyl bromide were added to initiate the reaction. The preparations were carried out in an all glass apparatus which consisted of a three neck flask fitted with a mechanical stirrer, reflux condenser, and a dropping funnel. Dry nitrogen gas was passed through the apparatus during the preparations.

In a typical preparation a solution of 5.1 gm of 9-bromoanthracene (0.02 moles) in 50 ml of anhydrous ether was added slowly from the dropping funnel to a mixture of 1.0 gm of magnesium (0.04 moles), 50 ml of anhydrous ether and five drops of ethyl bromide in the three neck flask. The mixture was continuously refluxed during the addition, which required approximately one hour, and for 23 hours after the addition was complete. At the end of the twenty-four hour reaction period a small quantity of the mixture was withdrawn from the flask and the amount of Grignard reagent present was determined (Gilman *et al.*, 1923).

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[2]For convenience the following abbreviations will be used: tri-*a*-naphthylborane, TNB; trimesitylborane, TMB; tri-9-anthracylborane, TAB.

[3]All melting points reported in this work are corrected.

In all of the preparations reported here the amount of 9-anthracylmagnesium bromide formed was in the range of 60 to 65 percent of the theoretical quantity.

In attempting to prepare TAB, freshly distilled boron trifluoride-etherate was dissolved in anhydrous diethyl ether and added slowly to the Grignard reagent in the flask in which the later had been formed. The reaction mixture was continuously stirred and refluxed during the addition and for various periods of time after the addition was complete. Dry nitrogen gas was passed through the system during the addition and subsequent refluxing. In several trial runs dry toluene was added to the Grignard reagent prior to the addition of the boron trifluoride-etherate and the ether was removed by distillation. This allowed the use of a higher reflux temperature during the preparation. The mole ratios of boron trifluoride-etherate to 9-anthracylmagnesium bromide used varied from 1:1.8 to 1:8 and the duration of reflux after addition was complete varied from 2 to 120 hours.

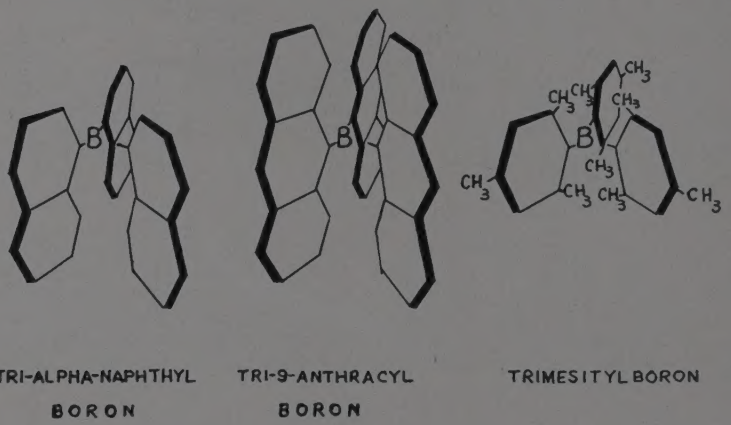

FIGURE 1. Diagrams illustrating the relative steric requirements of the aryl groups in TNB, TAB, and TMB.

After the refluxing period the entire mixture was added to 100 ml of cold water. When the initial reaction had subsided, 10 ml of concentrated hydrochloric acid was added slowly with stirring and shaking. The organic layer was removed, washed with four 100 ml portions of water, dried over anhydrous calcium chloride, and concentrated by distillation until slightly cloudy. The mixture was cooled in an ice bath and the precipitated solid was removed by filtration. The solid was yellow in color and identified as anthracene from its melting point (213 to 216°C) and that of its picrate derivative (137 to 139°C). The filtrate was evaporated to dryness and the residue was twice recrystallized from ligroin (b.p. 100 to 110°C). The bright orange solid product melted at 152.5°C and contained 2.80 percent boron, 85.80 percent carbon, and 5.05 percent hydrogen. The method used in the boron analysis has been previously described (Fowler and Kraus, 1940). These values were in good agreement with those calculated for di-9-anthracylborinic acid, $(C_{14}H_9)_2BOH$ (2.83 percent boron, 87.97 percent carbon, and 5.01 percent hydrogen). The deviations between the measured and calculated percent composition were attributed to a small amount of occluded ligroin in the sample. Di-9-anthracylborinic acid is very soluble in benzene, ether, chloroform and toluene, moderately soluble in ligroin, and slightly soluble in ethanol.

The reaction between boron trifluoride-etherate and 9-anthracylmagnesium bromide in mole ratios varying from 1:3.4 to 1:8 gave the same product, the diarylborinic acid. Refluxing the mixtures in toluene for periods up to 124 hours only improved the yield but did not produce TAB as originally predicted. No attempt was made to isolate and characterize the intermediate, di-9-anthracylboron fluoride.

Several triarylboron compounds have been purified by vacuum sublimation (Chu and Weismann, 1956a, b). A portion of di-9-anthracylborinic acid was subjected to such a treatment in an effort to simplify its purification. The bath surrounding the sublimation apparatus was maintained at temperatures between 115 and 120°C for a period of three hours. A yellow sublimate was identified as anthracene from its melting point. The sublimand was orange brown in color and melted at 145°C to a viscous dark brown liquid. A boron analysis of the material indicated that it was 9-anthracylboric oxide, $C_{14}H_9BO$ (found, 5.32 percent boron; calculated, 5.30 percent boron). The reaction was pictured as follows:

$$(C_{14}H_9)_2BOH \xrightarrow[\text{reduced pressure}]{120°C} C_{14}H_{10}+C_{14}H_9BO$$

When di-9-anthracylborinic acid was heated in air at 225°C slow decomposition occurred, leading to the formation of anthraquinone and 9-anthracylboric oxide. The former was identified from its melting point (283 to 286°C) and that of its oxime derivative (221 to 223°C).

$$(C_{14}H_9)_2BOH+3/2\ O_2 \xrightarrow{225°C} C_{14}H_8O_2+C_{14}H_9BO+H_2O$$

The stability of di-9-anthracylborinic acid in hot dilute hydrochloric acid, hot dilute sodium hydroxide, and in hot water was investigated by refluxing portions of the acid in each of these reagents. The first two reagents produced anthracene and substances that melted at 180 to 184°C and 209 to 213°C, respectively. The first of these was identified as 9-anthracylboronic acid, $C_{14}H_9B(OH)_2$, from its boron content (found, 4.82 percent boron; calculated, 4.88 percent boron). The second compound was identified as the disodium salt of 9-anthracylboronic acid, $C_{14}H_9B(ONa)_2$ (found, 3.70 percent boron; calculated, 3.76 percent boron). Boiling water caused no appreciable change in the original material.

DISCUSSION

A comparison of the Fisher-Hirschfelder models of TNB, TAB, and TMB indicates that the degree of crowding around the central boron atom increases in that order. TNB is fairly easy to prepare and the yields are good (Brown and Sujishi, 1948). TMB can be prepared in fair yields with some difficulty (Brown and Dodson, 1957). It seems reasonable to assume that if steric requirements of the aryl groups are the major factor in the preparation, TAB could be prepared using conditions approximating those employed in the synthesis of TMB. Such is not the case. Even when conditions more strenuous than those employed in the preparation of TMB are used, only the disubstituted aryl boron compound is formed.

The reactions of the arylborinic acids reported here and in the literature also points to an increase in the steric requirements of the aryl groups as one goes from *a*-naphthyl to the 9-anthracyl and finally to the mesityl group. The chemical behavior of di-9-anthracylborinic acid is very similar to that of di-*a*-naphthylborinic acid (Brown and Dodson, 1957). This would indicate that the steric influence of the two aryl groups, *a*-naphthyl and 9-anthracyl, are approximately the same. Since the chemical activity of dimesitylborinic acid is considerably less than that

of either, it must be concluded that the steric influence of the mesityl group is greater than that of either the *a*-naphthyl or the 9-anthracyl group.

The repulsion forces of the pi electrons in the anthracyl group, especially those in the vicinity of the 1 and 8 carbon atoms, might account for the reluctance of TAB to form. The models reveal that the 1 and 8 carbon atoms in the trisubstituted boron compound are very close to each other. Overlapping of pi electronic fields would lead to considerable repulsion between neighboring 9-anthracyl groups. In di-9-anthracylboron compounds, such as the fluoride or borinic acid, the two 9-anthracyl groups can rotate to a certain extent about the carbon-boron bond and the 1 and 8 carbon atoms of the two groups exhibit no overlapping. In TNB the possible repulsion of the pi electrons at the number 7 carbon atoms in the aryl groups is avoided because the three groups can rotate about the carbon-boron bond to such an extent that the number 7 carbon atoms do not overlap. Furthermore, there is evidence that TNB exists in both the symetrical and unsymetrical forms (Brown and Sujishi, 1948). In the latter form the number 7 carbon atoms in the three aryl groups are considerably far apart.

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The New Era of Flight: Aeronautics Simplified. *Lewis Zarem* and *Robert H. Maltby.* E. P. Dutton & Co., Inc. First Edition, 1956. 176 pp. $3.75.

This is a book on military aviation written for young people. It is written on a simplified level and is profusely illustrated with photographs of military aircraft, their flight operations, auxiliary equipment needed for crews, instruments which make flying more safe, etc. All types of Air Force planes are included, even some of the more recent research planes and guided missiles. Many of the current problems and terms are discussed in a simplified language such as the sonic barrier, thermal barrier, types of propulsion units, flight instruments, radar, landing approach systems, physical hazards of high speed and high altitude flight, etc. A section is also included on the U. S. air defense. As so often happens, simplification leads to some slightly inaccurate statements. However, at this level, this is not to be considered too much of a fault.

Throughout the book, I had the feeling that this was an Air Force propaganda piece (the authors are associated with the Wright Air Development Center). The Army is given very scant recognition (mention is made of their use of helicopters and a picture of the *Nike* is included) I searched in vain for any mention of the contributions of Naval Aviation or advances of nations other than the United States.

However, the proof of the pudding is in the eating. This is a book for young folks. I gave it to my twelve year old son and he read it avidly.

EDWARD S. FOSTER, JR.

BACTERIA PARASITIC ON PLANTS IN OHIO[1]

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In 1883 Burrill described and named a bacterium as the cause of the fire blight disease of pear. Since this first report of a bacterium pathogenic on plants, additional species have been described and Elliott (1951) enumerates 178 species as plant parasites.

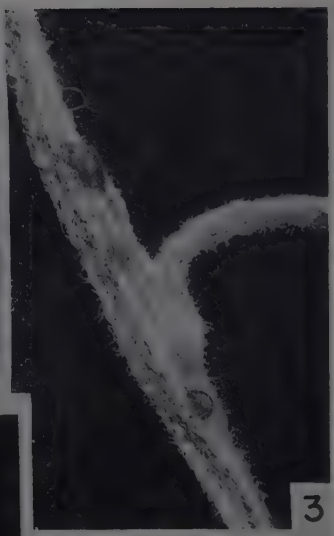
This report includes a list of 49 species and 2 varieties of bacteria parasitic on plants in Ohio. Bacterial plant diseases in Ohio, such as alfalfa wilt, cucurbit wilt, corn leaf blight and wilt (Stewart's disease), fire blight of apple and pear,

FIGURE 1. Bacterial wilt of carnation.

crown gall, soft rot of many vegetables, and carnation wilt have resulted in great losses of these crops in many different years. Some of these bacterial diseases are illustrated in figures 1 to 5. Fire blight of pear has all but eliminated commercial pear production in the state, although recent research by Winter and Young

[1]Publication 605, Department of Botany and Plant Pathology, The Ohio State University.

THE OHIO JOURNAL OF SCIENCE 58(3): 145, May, 1958.



2. Twig blight phase of bacterial fire blight of apple.
3. Enlargement of a portion of figure two with bacterial exudate on stem.
4. Bacterial leaf blight (Stewart's disease) of corn; small portions of diseased tissue removed for microscopic examination.
5. Small portion of corn leaf with bacterial exudate clouding the water.

(1953, 1954) and others indicates that this disease may soon be effectively controlled in Ohio.

The following compilation of bacteria parasitic on Ohio plants is based upon specimens in herbaria of The Ohio State University, reports from the available literature, and numerous collections and observations of the author throughout Ohio. The Actinomycetales, sometimes considered to be related to the true bacteria, are included in this compilation.

The genera of bacteria are those recognized by Elliott (1951). The nomenclature for the host plants is from *Gray's Manual of Botany*, 8th edition, 1950 or from Bailey's *Manual of Cultivated Plants*, revised edition, 1949.

Eubacteriales

Agrobacterium rhizogenes (Riker *et al.*) Conn
Pyrus malus L. Hairy root.

Agrobacterium tumefaciens (E. F. Sm. & Towns.) Conn
Beta vulgaris L. Crown gall; stem and/or root gall of all hosts.
Chrysanthemum frutescens L.
C. morifolium (Ramat.) Hemsl.
Euonymus kiautschovicus Loes.
E. fortunei (Turcz.) Hand.-Mazz.
Pelargonium sp.
Prunus sp. (cherry)
P. americana Marsh.
P. persica (L.) Batsch
Pyrus communis L.
P. malus L.
Rosa sp. (cult.)
Rubus sp. (blackberry)
Rubus sp. (dewberry)
R. idaeus L.
R. occidentalis L.
R. ursinus Cham. & Schlecht.
Salix sp.
Vitis sp. (cult.)
Wistaria sp.

Bacterium stewartii E. F. Sm.
Zea mays L. Leaf blight and wilt.

Corynebacterium fascians (Tilford) Dowson
Chrysanthemum morifolium (Ramat.) Hemsl. Fasciation of all hosts.
Dianthus caryophyllus L.
Gypsophila paniculata L.
Lathyrus odoratus L.
Nicotiana tabacum L.
Pelargonium hortorum Bailey
Petunia hybrida Vilm.

Corynebacterium flaccumfaciens (Hedges) Dowson
Phaseolus vulgaris L. Wilt.

Corynebacterium insidiosum (McCull.) H. L. Jens.
Medicago sativa L. Wilt.

Corynebacterium michiganense (E. F. Sm.) H. L. Jens.
Lycopersicon esculentum Mill. Stem canker and fruit spot.

Corynebacterium sepedonicum (Spieck. & Kotth.) Skapt. & Burkh.
Solanum tuberosum L. Ring-rot of tuber.

Erwinia amylovora (Burr.) Winslow *et al.*
Amelanchier canadensis (L.) Medic. Fire blight of all hosts.
Cotoneaster aivaricata Rehd. & Wils.
C. foveolata Rehd. & Wils.
Cydonia oblonga Mill.
Prunus sp. (cherry)
Prunus sp. (plum)
P. serrulata Lindl.
Pyracantha coccinea Roem.
Pyrus baccata L.
P. communis L.
P. malus L.

Erwinia atroseptica (Van Hall) Jennison
Solanum tuberosum L. Blackleg; stem rot.

Erwinia carotovora (L. R. Jones) Holland
Allium cepa L. Soft rot of all hosts.
Apium graveolens L.
Brassica oleracea L.
B. rapa L.
Cyclamen persicum Mill.
Daucus carota L.
Hyacinthus orientalis L.
Iris germanica L.
Lactuca sativa L.
Lycopersicon esculentum Mill.
Rheum rhaponticum L.
Solanum tuberosum L.
Zantedeschia sp.

Erwinia chrysanthemi Burkholder *et al.*
Chrysanthemum morifolium (Ramat.) Hemsl. Stem rot and wilt.

Erwinia dissolvens (Rosen) Burkh.
Zea mays L. Stalk rot.

Erwinia tracheiphila (E. F. Sm.) Holland
Cucumis melo L. Wilt of all hosts.
C. sativus L.
Cucurbita maxima Duchesne
C. pepo L.

Pseudomonas alliicola Starr & Burkh.
Allium cepa L. Soft rot.
Reported, but possibly *Erwinia carotovora*, and not this species.

Pseudomonas angulata (Fromme & Murray) Holland
Nicotiana tabacum L. Angular leaf spot; blackfiire.

Pseudomonas apii Jagger
Apium graveolens L. Leaf spot.

Pseudomonas atrofaciens (McCull.) F. L. Stev.
Triticum aestivum L. Basal glume rot.

Pseudomonas berberidis (Thornberry & H. W. Anders.) Stapp
Berberis thunbergii DC. Leaf spot.

Pseudomonas cannae (Bryan) Stapp
Canna generalis Bailey Bud rot.

Pseudomonas caryophylli Burkh.
Dianthus caryophyllus L. Wilt.

Pseudomonas coronafaciens (Elliott) F. L. Stev.
Avena sativa L. Halo blight; leaf spot.

Pseudomonas coronafaciens atropurpurea (Reddy & Godkin) Stapp
Bromus inermis Leyss. Leaf spot; blight.

Pseudomonas delphinii (E. F. Sm.) Stapp
Delphinium sp. Leaf spot; black spot.

Pseudomonas erodii Lewis
Pelargonium sp. Leaf spot.

Pseudomonas glycinea Coerper
Glycine max (L.) Merr. Leaf spot; blight.

Pseudomonas lachrymans (E. F. Sm. & Bryan) Carsner
Cucumis sativus L. Angular leaf spot; fruit spot.

Pseudomonas marginata (McCull.) Stapp
Gladiolus sp. Scab of corms.

Pseudomonas medicaginis Sackett
Medicago sativa L. Stem blight.

Pseudomonas mori (Boyer & Lambert) Stevens
Morus rubra L. Stem and leaf blight.

Pseudomonas phaseolicola (Burkh.) Dowson
Phaseolus vulgaris L. Halo blight of leaf, stem and pod.

Pseudomonas pisi Sackett
Pisum sativum L. Stem, leaf and pod blight.

Pseudomonas rhizoctonia (R. C. Thomas) Burkh.
Lactuca sativa L. Rosette.

Pseudomonas striafaciens (Elliott) Starr & Burkh.
Avena sativa L. Stripe blight.

Pseudomonas syringae Van Hall
Phaseolus lunatus L. Brown-spot blight.
Trifolium repens L. Leaf spot.

Pseudomonas tabaci (Wolf & Foster) Stevens
Glycine max (L.) Merr. Wildfire; leaf spot.
Nicotiana tabacum L. Wildfire; leaf spot.

Pseudomonas tomato (Okabe) Alstatt
Lycopersicon esculentum Mill. Speck (fruit, stem, and leaf).

Pseudomonas viburni (Thornberry & Anderson) Stapp
Viburnum opulus L. Leaf spot.

Pseudomonas woodsii (E. F. Sm.) Stevens
Dianthus caryophyllus L. Leaf spot.

Xanthomonas campestris (Pam.) Dowson
Brassica oleracea L. Black rot, blight of all hosts.
B. juncea (L.) Coss.
B. rapa L.
Raphanus sativus L.

Xanthomonas gummisudans (McCull.) Starr & Burkh.
Gladiolus sp. Leaf blight.

Xanthomonas hederae (Arn.) Dowson
Hedera helix L. Leaf spot.

Xanthomonas papavericola (Bryan & McWhorter) Dowson
Papaver rhoeas L. Leaf and stem blight.
P. somniferum L.

Xanthomonas pelargonii (N. A. Brown) Starr & Burkh.
Pelargonium hortorum Bailey Leaf blight.
P. peltatum Ait.

Xanthomonas phaseoli (E. F. Sm.) Dowson
Phaseolus lunatus L. Leaf, stem and pod blight.
P. vulgaris L.

Xanthomonas phaseoli sojense (Hedges) Starr & Burkh.
Glycine max (L.) Merr. Pustule; leaf spot.

Xanthomonas pruni (E. F. Sm.) Dowson
Prunus americana Marsh. Leaf spot, fruit spot and stem canker.
Prunus persica (L.) Batsch

Xanthomonas solanacearum (E. F. Sm.) Dowson
Lycopersicon esculentum Mill. Wilt of all hosts.
Nicotiana tabacum L.
Solanum tuberosum L.

Xanthomonas translucens (L. R. Jones, A. G. Johns. & Reddy) Dowson
Hordeum vulgare L. Leaf blight.
Triticum aestivum L. Leaf blight; black chaff.

Xanthomonas vesicatoria (Doidge) Dowson
Lycopersicon esculentum Mill. Fruit spot; leaf spot.

Actinomycetales

Streptomyces scabies (Thaxt.) Waksman & Henrici
Beta vulgaris L. Root scab.
Raphanus sativus L. Root scab.
Solanum tuberosum L. Tuber scab.

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Winter, H. F. and **H. C. Young.** 1953. Fireblight control may be achieved by antibiotics. Ohio Farm and Home Research 38: 84–85.
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Geology and Ourselves. *F. H. Edmunds.* Philosophical Library, Inc., New York. First edition, 1956. 256 pp. $10.00

As the title indicates, this is a book on geology for the layman. The author assumes that the reader can understand words of more than two syllables but that he is unacquainted with the jargon of the specialist. The first chapter summarizes the beginnings of the science, and the next four introduce the reader to minerals and rocks, fossils, maps, and geologic history. The remainder of the book is devoted primarily to economic applications of geology in water supply, structural engineering, mining for coal and ores, exploration for oil and gas, and agriculture. The final chapter is on geology for the amateur. The book is illustrated with thirteen photographs and numerous line drawings.

The author, a member of the Geological Survey of Great Britain, writes well and communicates his own enthusiasm for the subject. He has taken, however, a relentlessly provincial point of view. The whole discussion of geological principles is based on the local rock record, and virtually every example of applied geology is from the British Isles. Although the author expresses the hope that the book will have "more than an insular appeal," this is exactly what it does not have. *Geology and Ourselves* is strongly recommended to those readers of this review who happen to live in the Cotswold Hills, the Midlands, or the Lake Country.

ROBERT L. BATES

THE CHEMICAL COMPOSITION OF CATTLE HAIR. I. THE FAT, ASH AND NITROGEN CONTENT[1]

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Practically nothing is known about the composition of cattle hair although considerable use in identification and diagnosis apparently is made of chemical and microscopic analyses of hair from other species, including man. In connection with some detailed analysis to determine the melanin and mineral composition of cattle hair estimates were made on the amount of fat, ash, and total nitrogen.

EXPERIMENTAL PROCEDURE

Hair samples were cleaned before analysis by boiling for one-half hour in a 0.5 percent dreft solution followed by rinsing with hot water. The hair was then dried at 100°C and subsamples were used in the determination of ash and nitrogen. The determination of ash consisted of ashing a known amount of the cleaned hair for one hour in a muffle furnace at 540°C. Nitrogen determinations were made on a Kjeldahl apparatus.

The hair for the analysis of fat was treated in three different ways as indicated in table 1, *i.e.*, (1) washed in hot water followed by washing in 0.5 percent boiling dreft solution for ½ hour, rinsed and dried; (2) washed in boiling 0.5 percent dreft solution for ½ hour, rinsed and dried; and (3) rinsed in lukewarm water and dried. Method 2 was the method of choice in determining fat, ash, nitrogen and later melanin. Subsamples of hair for fat determination were extracted in petroleum ether for 96 hours using a Soxhlet extractor.

RESULTS AND DISCUSSION

The mean values for fat, ash and nitrogen are presented in table 1 along with the range for each set. The method of preparing the hair appears to have a significant effect on the values obtained for fat and indicates the importance of a standard procedure. The effect on ash and nitrogen would be similar. It can be noted that the nitrogen content of cattle hair is but slightly lower than the values for human hair given by Hawk *et al.* (1947).

In table 2 are summarized the values for means and standard errors for the ash content of cattle hair of different colors. Black hair, from cattle either carrying the recessive gene for red or those thought to be homozygous for its allele, was significantly higher in its ash content than hair from cattle that were brown (tan), red or white. The mean for black hair thus appears to be approximately 2.4 percent and of white, red or brown hair to be within the range of 1.4 to 1.6 percent. Further effort is being put forth to determine whether one or more specific elements are involved in this difference and also to ascertain whether or not there are elemental differences between hairs of other colors.

By spectographic analysis the following elements were identified: barium, boron, calcium, copper, iron, lead, potassium, magnesium, manganese, phosphorus, silicon, silver sodium and zinc. Potassium was the only element found in some samples that was not found in all. In some samples of white hair it was not identified. The ash of hair from Holsteins (both black and white), Guernseys and Shorthorn-Guernsey crossbreds was inspected.

The principal interest in the nitrogen content was in the melanin fraction. The preliminary melanin values ranged from 1.63 to 11.83 percent and definitely

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appeared to be associated with the color of the hair. An inspection of the data showed no relationships between the nitrogen and melanin values for hair (black, white and tan) from Holstein-Friesians, Angus and Guernseys. A further comparison of the melanin values of hair taken from the same cows from January to October showed considerable difference in some cows but not in others. Hair from identical twins tended to give similar values if taken on the same day and to vary similarly with seasonal changes. It was noted also that the melanin

TABLE 1

The fat, nitrogen and ash content of cattle hair

Constituent	No.	Mean	Range
		(gm/100)	(gm/100)
Fat	6	0.64	0.54– 0.77[1]
"	17	1.49	0.95– 1.90[2]
"	4	2.28	1.10– 3.10[3]
Ash	138	2.04	0.28– 3.08
N	12	13.46	12.40–14.40
"	Human Hair		14.60–15.80 (Hawk *et al., 1947*)

[1]Washed in hot water followed by washing with hot dreft solution (½%).

[2]Washed in dreft solution (½%).

[3]Rinsed in luke warm water.

TABLE 2

The ash content of different colored cattle hair

Color	No. of Samples	Ash Mean	S.E.
		(gm/100)	
White	24	1.408±	.0113
Red	22	1.662±	.1910
Brown	14	1.668±	.0365
Black (R.C.)	45	2.385±*	.0678
Black (x)	33	2.455±	.0748

*Difference highly significant ($P < .01$) from those preceding.

content varied, depending on the area of the body from which it was clipped with the hair from the head being the lowest. To a lesser extent that from the shoulders was the highest. Intermediate values were obtained for the rump, thigh, saddle and neck. Samples for subsequent analyses have been taken from the rump or thigh areas whenever possible. For melanin studies it was found also to be advantageous to brush the area well with a grooming brush before clipping.

SUMMARY AND CONCLUSIONS

An analysis of hair from 177 different cattle showed the average fat, ash, and nitrogen content to be 1.49, 2.04, and 13.46 percent, respectively when the hair was prepared for analysis according to a standard procedure. Hair from different cattle were used for the analysis of each of the three constituents. The washing

procedure prior to extraction with petroleum ether affected the value obtained for fat.

The ash content varied from 1.4 to approximately 2.4 percent, respectively for the mean value of white and black hair. The values for red and brown were intermediate but statistically indistinguishable from the white. Whether or not black cattle carried the gene for red appeared not to affect the ash content of the hair they produced.

From the ash the following elements were identified: boron, barium, calcium, copper, iron, lead, potassium, magnesium, manganese, phosphorus, silicon, silver, sodium and zinc. Potassium was not found in the ash from some of the samples of white hair.

The melanin content ranged from extremes of 1.63 to 11.83 percent as compared to 12.4 to 14.4 percent for total nitrogen, with no apparent relationship between these two constituents. Seasonal variations in the melanin content of hair from the same cattle sampled at different times appear to be affected both by environment and genotype. The area of body sampled also affected the melanin content.

The value of a standardized procedure in hair sampling is suggested.

ACKNOWLEDGMENTS

The technical assistance Mr. G. W. Kerr in procurring the hair samples and the financial assistance of H. W. Norton, Jr., Chairman, Research Committee of the Holstein-Friesian Association of America are gratefully acknowledged.

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The Admirable Discourses of Bernard Palissy. *Translated by Aurèle La Rocque.* Univ. of Illinois Press. 1957. vi+264 pp. $5.50.

Bernard Palissy has been well known by historians of pottery for his development of French Faience ware, and for his artistry in making notable platters, figurines, etc. His claim to fame as a scientist has been known principally to French geologists, mainly because his work in science was available only through his book *Discours Admirables*, published in 1580. The present translation by a bilingual geologist establishes Palissy as the first to see or do or think of many things. Professor LaRocque describes the book as "a didactic work which might well be called a textbook of geology, though it contains much information on other subjects as well." Palissy was a fantastically keen observer, and he thought about the things he saw. His presentation is in the form of argument between Theory and Practice, with Practice setting Theory straight about each subject in turn. He describes a method for building ponds, treating porous soil so as to seal the pond bottoms, planting trees to prevent soil erosion, how wells are recharged, how pumps work, how goitre is due to water character, why there is a lag in change of levels, why the transmutation of metals is impossible, what causes rainbows, what three forms of crystals are formed in water, how fossilization takes place, what is salt, etc., etc. Footnotes by the translator add immensely to the significance of Palissy's statements. For example, a short section is entitled "Copy of the labels," and LaRocque's footnote informs us that "Palissy's teaching methods were revolutionary for his time. Not only did he use specimens to illustrate his lectures but he expected his readers to visit his museum, book in hand, to do laboratory work, as we would call it now, to verify his statements. In this he was so much ahead of his time that nearly three centuries were to elapse before his method was generally adopted."

Palissy finished his book with a summary of the main maxims contained in the book. LaRocque adds a glossary and bibliography to his translation, thus adding usefulness for the general reader.

The Admirable Discourses, thus made available to American readers, establishes the role of Palissy as a founding father of geology, and the LaRocque translation has been a service to historians of science.

THOMAS H. LANGLOIS

TWO NEW NORTH AMERICAN BUPRESTIDAE

(COLEOPTERA)

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In my studies of the North American Buprestidae, the following two new species were found.

Dicerca juncea n. sp.

Male.—Narrow, elongate, convex; cupreous, more brilliant beneath; labrum, antennae, tips of tibiae and tarsae with a greenish cast.

Head depressed along median line; surface roughly sculptured, with an irregular, smooth, chitinized area each side of middle on vertex, pubescence sparse; antennae not reaching to middle of pronotum when laid along side, serrate from the fourth segment.

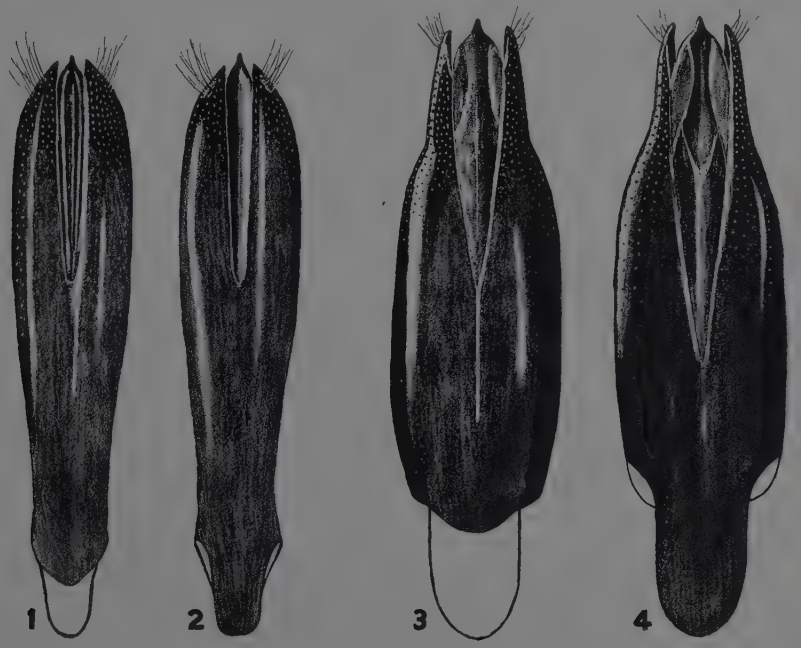

FIGURE 1. Dorsal view, ♂ genitalia of *Dicerca juncea* n. sp. FIGURE 2. Ventral view, ♂ genitalia of *Dicerca juncea* n. sp. FIGURE 3. Dorsal view, ♂ genitalia of *Buprestis parmaculativentris* n. sp. FIGURE 4. Ventral view, ♂ genitalia of *Buprestis parmaculativentris* n. sp.

Pronotum wider than long, widest at base, constricted at apex; sides nearly straight, converging from base to apex; disk convex, with light median depression; surface with two irregular smooth areas each side of middle, separated by irregular coarse punctures, punctures more numerous at sides. Scutellum small, round.

Elytra slightly wider than pronotum at base, widest about middle; sides divergent to about middle then strongly converging to bispinose apices; disk convex; surface striately punctured

on basal two-thirds with irrgular smooth black interspaces, interspaces carinate on apical third' each elytron with irregular densely punctate areas extending from lateral margin midway to suture.

Beneath with abdomen densely, irregularly, coarsely punctured, apex of last sternite rectangularly emarginate. Hind coxal plates notched, with tooth on outer side of notch.

Female.—Differs from the male by having a rectangular tooth in the apical sinus.

Length 14.2 mm.; width 4.8 mm.

Holotype ♂ labeled Navarre, Fla., Aug. 17, 1943, M. Wright. Allotype from Ocala National Forest, Marion Co., Florida, September 4, 1938, Hubbell and Friauf. Paratypes labeled Florida; Southport, N. C., Sept. 21, R. W. Dawson; Okefenokee Swamp, Ga., Aug. 3, 1934, P. A. McKinstry and Mobile, Ala. Nov. 30, 1910, T. Van Aller, all in collection of author. Paratype labeled Billy's Island, Okefenokee Swamp, Ga., July 1912 H. W. Wenzel Collection, The Ohio State University. Paratype labeled Tarpon Springs, Fla., Mar. 20, 1950, on maple, H. and A. Howden in collection of Dr. H. F. Howden to whom I am indebted for loan of material.

This species is closest to *D. obscura* (Fab.). It differs by being more cupreous; narrow, elongate form; pronotum with sides nearly straight and converging anteriorly; and by the disk of pronotum being channeled from base to apex. The male genitalia differ also.

Buprestis parmaculativentris n. sp.

Male.—Form of *B. maculativentris* Gory, only more robust; shining dark bronze, front of head, mandibles, anterior angles of pronotum and lateral spots on all ventral segments reddish yellow.

Head convex, median depression above clypeus; surface densely coarsely punctured.

Pronotum much wider than long, wider at base than apex; sides subparallel at base then rounded to constricted apex; disk convex; surface densely coarsely punctured between irregular smooth areas. Scutellum small, nearly round.

Elytra much wider than widest part of pronotum, widest about middle; sides rounded in front, subparallel at middle then broadly rounded to truncate apices which are slightly prolonged at suture, forming a small tooth; surface feebly striate, punctures of striae small, interspaces slightly convex, punctures small, irregular.

Beneath abdomen densely coarsely punctured, last sternite truncate; first ventral segment longitudinally sulcate at middle. Anterior tibia armed with an internal recurved spine at apex.

Length 16.5 mm.; width 6.8 mm.

Holotype male collected on pine in Chisos Mountains, Tex., June 30, 1957 by D. J. and J. N. Knull, in collection of author.

This species runs to *B. maculativentris* in Helfer's key (1941). It is shorter, more robust and with interspaces less convex. The male genitalia are quite different from those figured by Helfer.

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Helfer, J. R. 1941. A revision of the genus *Buprestis* of North America north of Mexico (Coleoptera, Buprestidae). Ent. Amer. 21: 123–199.

CTENICERA IDAHOENSIS A NEW NAME FOR *CTENICERA ACUTA* (KNULL) (COLEOPTERA: ELATERIDAE)

It is necessary to change the name *Ctenicera acuta* (Knull) 1957, Ohio Jour. Sci. 57: 202 which was removed from *Aplastus*.

In 1855 Mulsant and Guillebeau described *Athous acutus* which was later placed in *Corymbites*, a synonym of *Ctenicera*. *Ctenicera idahoensis* is proposed for this species.

J. N. KNULL

AFRICAN ANCESTRY OF THE WHITE AMERICAN POPULATION*

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Defining a racial group generally poses a problem to social scientists. A definition of a race has yet to be proposed that is satisfactory for all purposes. This is particularly true when the racial group has minority group status as does the Negro group in the United States. To many persons, however, the matter of race definition is no problem. They view humanity as being divided into completely separate racial compartments. A Negro is commonly defined as a person having *any known trace* of Negro ancestry or "blood" regardless of how far back one must go to find it. A concomitant belief is that all whites are free of the presumed taint of Negro ancestry or "blood."

The purpose of this research was to determine the validity of this belief in the non-Negro ancestry of persons classified as white. Current definitions of Negro may have serious limitations when used as bases for classifying persons according to ancestry (Berry, 1951). The terms *African* and *non-African* will be used rather than *Negro* and *white* when discussing the ancestry of an individual. Each of the former pair of terms has a more specific referent which is the geographic point of origin of an individual. At the same time, the two pairs of terms are closely related. Hence, this paper is the report of an attempt to estimate the percentage of persons classified as white that have African ancestry or genes received from an African ancestor.

This raises a question concerning the relationship between having an African ancestor and receiving one or more genes from this ancestor. Since one-half of an individual's genetic inheritance is received from each parent, the probability of a person with one African ancestor within the previous eight generations receiving *any single gene* from this ancestor is equal to or greater than $(0.5)^8$ or 3.9063×10^{-3}. It has been estimated that there are approximately 48,000 gene loci on 24 chromosome pairs (Stern, 1950). The probability that an individual with one African ancestor has *one or more* genes derived from this ancestor is equal to $1-(1-3.9063 \times 10^{-3})^{24,000}$ or greater than 0.9998. Having more than one African ancestor increases this probability. One final remark needs to be made. Some degree of African ancestry is not necessarily related to the physical appearance of the individual. Many of the genes possessed by virtue of descent from an African do not distinguish the bearer from persons of non-African ancestry. They are the genes or potentials for traits which characterize the human race. Nevertheless, these genes represent an element in the biological constitution of the individual inherited from an African.

RESEARCH METHODOLOGY

The research methodology of this study involved constructing a *genetic probability table.* The primary function of this type of table is to ascertain the distribution within a known population of a variable that can not be observed directly. It is frequently used to estimate the changes that occur in the genetic composition of a population over a period of time. There are three basic steps in the computation of a genetic probability table.

1. A series of assumptions which serve as a basis for the table is made. These assumptions may refer to the initial distribution of the variable within the popu-

*Revision of a paper read at the annual meeting of The Ohio Academy of Science held in Bowling Green, Ohio, April 19, 1957.

lation, the effect of biological and non-biological factors on the distribution, or the interrelationships of these factors. In some cases, these assumptions may be derived from available empirical data.

2. On the basis of these assumptions, the probability distributions of the variable within the population for successive time intervals are computed. This is done by applying the rules of probability relevant to the principles of biological inheritance to the changes that are known to have occurred in the observable characteristics of the population.

3. The validity of the probability table is determined by comparing the probability values included in the table to probability values obtained from empirical studies based on other research methods. The extent to which these values correspond is a measure of the validity of the table.

Sources of data. The best data available for use in estimating the biological background of Americans are those dealing with the population of this country. Official records have been kept of the white and Negro population since 1790 by the Bureau of the Census and of the influx of foreign population to this country since 1820 by the Immigration and Naturalization Service. Numerous estimates of population and immigration figures have been made for the period 1660 to 1820. There is general agreement among historians, statisticians, and population analysts on the relative reliability of the data for the years since 1750 only (Carey, 1853; Bromwell, 1856; Bancroft, 1891; Greene, 1932; U. S. National Resources Committee, 1938). Estimates have been made of the volume of illegal smuggling of slaves into this country between 1808 and 1860 (U. S. Bureau of the Census, 1909; Dublin, 1928). Thus, it was possible to obtain usable data for each decennial period since 1750.

Assumptions and estimating equations.—In this study, all persons were classified into four racial-ancestral categories: white persons with no African ancestry (wna), white persons with some degree of African ancestry (wa), Negroes with some degree of non-African ancestry (nna), and Negroes with African ancestry only (na). The following assumptions were used as bases for statistically estimating the probability of African and non-African ancestry.

1. The white population of the American colonies in 1750 contained no persons of African ancestry. Any African element introduced into the background of supposedly white persons prior to 1750 was regarded as unimportant since the probability of possessing genes from any given ancestor decreases rapidly after ten generations from the introduction of these genes.

2. All individuals classified as Negro have some degree of African ancestry.

3. The probability of a male member of any of the four racial-ancestral categories being a partner in a fecund mating during a given period of time is equal to the proportion of the total population in the category at the beginning of the time period. In other words, if one-tenth of the total population are white persons of non-African ancestry, one-tenth of all fecund sexual contacts involve white males of non-African ancestry. The same is assumed for females.

4. The probability of persons classified as white mating with persons classified as Negro is one-twentieth of what would be expected if mating were random. To illustrate, if 90 percent of the population were white and 10 percent were Negro and *mating were random*, 18 percent of all fecund matings would involve a white and a Negro. According to this assumption of *selective mating*, the percentage of fecund matings involving members of different racial categories would be nine-tenths of one percent in this case. It should also be remembered that virtually all of the offspring of these mixed matings would be classified as Negro.

5. The proportion of the increase in population due to causes other than immigration from Africa and Europe during a given period that can be assigned to a racial-ancestral category is equal to the probability of a live birth being a

member of that category. These causes include natural increase, emigration, and immigration from racially mixed areas (West Indies, Mexico, Central and South America). If one-third of the live births during a given period are white persons of non-African ancestry, one-third of the increase due to these causes is comprised of white persons of non-African ancestry.

6. All persons immigrating to the United States from Europe are of non-African ancestry only. Due to the small number of African Negroes in Europe, the incidence of African ancestry among Europeans is relatively small.

7. All persons immigrating to the United States from areas in Africa are of African ancestry and one-tenth of them have some degree of non-African ancestry.

Several equations were used in computing the probability of an individual drawn at random from the population being a member of each of the four racial-ancestral categories. The first was used to estimate the number of white persons with only non-African ancestry. The crucial problem was estimating the portion of the population increase due to causes other than immigration from Europe and Africa during a censual period that had no African ancestry. The symbol P(wna) was used to represent the proportion of the population that was both white and of non-African ancestry only in a given censual year. Under the third and fifth assumptions, the proportion of the population increase mentioned above during the subsequent period assigned to this racial-ancestral category equalled $P(wna)^2$. The assumption of selective mating (assumption 4) required an additional increment. P(w) and P(n) represented the proportions of the population that were classified as white and Negro, respectively. The proportion of the increase falling in the mixed parentage category during the following ten-year period was calculated to be P(w)P(n). Although 95 percent of this group was assigned to the white category under the .05 selective mating factor of the fourth assumption, only a proportion equal to

$$.95\,\frac{P(wna)^2}{P(w)^2}$$

was assigned to the category of white with no African ancestry. This limitation was imposed by assumption 3. Hence, the proportion of the increase classified as white with no African ancestry equalled

$$P(wna)^2+.95\,\frac{P(wna)^2P(n)}{P(w)}$$

The absolute number in this category was obtained by multiplying by the magnitude of this population increase.

According to the sixth assumption, immigration from Europe during a censual period included no persons of African ancestry. The number of whites with no African ancestry at the end of a censual period was obtained by adding these two figures to the number in this category at the beginning of the period. The final form of the equation was

$$N(wna)=Y+P(wna)^2Z+.95\,\frac{P(wna)^2P(n)}{P(w)}\,Z+I_E$$

where

Y	=	estimated number of whites having no African ancestry in the preceding censual year
P(wna)	=	probability of a person being classified as white with no African ancestry in the preceding censual year
P(n)	=	probability of a person being classified as Negro in the preceding censual year
P(w)	=	probability of a person being classified as white in the preceding censual year
Z	=	increase due to causes other than immigration from Europe and Africa during preceding decade
I_E	=	immigration from Europe during preceding decade

The estimated number of whites having some degree of African ancestry was obtained by subtracting the estimated number of whites having no African ancestry from the total number of persons classified as white.

A similar procedure was followed for the Negro ancestral categories. To estimate the number of individuals that are Negro and have only African ancestry for a given censual year, another equation was used.

$$N(na) = X + P(na)^2 Z + .95 \frac{P(na)^2 P(w)}{P(n)} Z + .90\ I_A$$

where
- X = estimated number of Negroes having only African ancestry in the preceding censual year
- $P(na)$ = probability of a person being classified as Negro with African ancestry only in the preceding censual year
- $P(n)$ = probability of a person being classified as Negro in the preceding censual year
- $P(w)$ = probability of a person being classified as white in the preceding censual year
- Z = increase due to causes other than immigration from Europe and Africa during preceding decade
- I_A = immigration from Africa during preceding decade.

The estimated number of Negroes having some degree of non-African ancestry was obtained by subtracting the number of Negroes with only African ancestry from the total number of Negroes in the population. The probability values for a given censual year needed to complete the genetic probability table were obtained by dividing these four sets of numerical estimates by the total white and Negro population at that time.

Criteria of validity.—Three types of empirical studies were used in determining the validity of the genetic probability table based upon the above assumptions. These included studies of the mixed ancestry of Negro groups, the frequency of children born of mixed parentage, and the frequency of passing.

RESEARCH RESULTS

A genetic probability table was constructed on the basis of the above data and assumptions. This table included the probabilities of an individual drawn at random from the population of the United States being a member of the four racial-ancestral categories. These probabilities were computed for every tenth year from 1750 through 1780 and each censual year since 1790. In order to highlight the relative size of the two groups with mixed ancestry, the probability values in this table were converted to absolute numbers. Table 1 includes these data for successive censual years. The percentages of the two racial categories that have both African and non-African ancestry are also included.

The data in table 1 indicate that approximately 21 percent of the persons classified as white in 1950 have an African element in their inherited biological background. The percentage of persons classified as white having some degree of African ancestry was extremely small in 1790. The percentage figures for successive censual years increased most rapidly between 1790 and 1850. Although this is partly a function of the computational methods used, it is characteristic of interbreeding populations. The figures for the period 1850 to 1890 were comparatively stable. Between 1900 and 1930, the percentage declined slightly. These two shifts were primarily the result of large-scale immigration from Europe. With the curtailing of this immigration, the percentage values began increasing again in 1930.

One final question pertains to the validity of these data. As mentioned above, three criteria were used to ascertain the validity of the probability values used in deriving table 1. Two of the criteria involved the incidence of mixed

ancestry among persons classified as Negro. First, the percentage of Negroes that had some degree of non-African ancestry was computed for each censual year. Table 1 shows that from 64.8 to 73.0 percent of Negroes had some degree of non-African ancestry in the last four censual years. These figures correspond closely to those included in studies of Negro groups made by Hrdlicka (1928),

TABLE 1

Total white and Negro population, white population with African ancestry and Negro population with non-African ancestry, United States, 1790–1950

Year	White population			Negro population		
	Total (000's)	African ancestry		Total (000's)	Non-African ancestry	
		Number (000's)	%		Number (000's)	%
1790	3,172	62	2.0	757	144	19.0
1800	4,306	164	3.8	1,002	209	20.9
1810	5,862	303	5.2	1,378	450	32.7
1820	7,887	623	7.9	1,772	620	35.0
1830	10,537	1,134	10.8	2,329	842	36.2
1840	14,196	1,939	13.7	2,874	1,041	36.2
1850	19,553	2,975	15.2	3,639	1,389	38.2
1860	26,923	4,508	16.7	4,442	1,738	39.1
1870	33,589	6,035	18.0	4,880	1,935	39.7
1880	43,403	7,961	18.3	6,581	3,248	49.4
1890	55,101	10,383	18.8	7,489	3,902	52.1
1900	66,809	13,020	19.5	8,834	5,002	56.6
1910	81,364	14,150	17.4	9,828	6,050	61.6
1920	94,120	16,703	17.7	10,463	6,780	64.8
1930	108,864	20,120	18.5	11,891	8,086	68.0
1940	118,215	23,035	19.5	12,866	8,993	69.9
1950	134,942	28,366	21.0	15,042	10,980	73.0

TABLE 2

Estimated extent and rate of passing, United States, 1861–1950

Period	Estimated number of persons passing	Annual mean	Annual rate*
1861–1890	90,900	3,030	0.68
1891–1910	101,300	5,065	0.68
1911–1930	183,200	9,160	0.93
1931–1940	42,700	4,270	0.36
1941–1950	155,500	15,550	1.21

*Rate per 1,000 Negro population per year.

Herskovits (1930), and Hooton (1939). Second, estimates of the percentage of Negroes born of mixed parentage were made on the basis of the probability values included in the gentic probability table. The percentage born of mixed parentage varied between 7.9 percent in 1850 and 8.4 percent in 1920. These computed values do not conflict with any of the data cited by Herskovits (1928), Day (1932), and Frazier (1939). Furthermore, these values are almost

the exact values needed to account for the rates of gene transfer computed by Glass and Li (1953).

The third criterion centered around the phenomena of passing. The increase in the number of persons classified as white having some degree of African ancestry given in table 1 could have occurred only if there were a continuing influx of persons into the white group from the Negro group. The magnitude and rate of passing needed to account for the indicated increase were computed for the period 1860 to 1950. These data are given in table 2. They fall well within the range of frequency of passing as empirically estimated by Hart (1921) Burma (1946), and Eckard (1947). The data in table 2 also indicate that the rate of passing is increasing.

CONCLUSIONS

The data presented in this study indicate that the popular belief in the non-African background of white persons is invalid. Over twenty-eight million white persons are descendants of persons of African origin. Furthermore, the majority of the persons with African ancestry are classified as white. Finally, if the volume of immigration remains at the present relatively low level, the percentage of persons having mixed ancestry will increase in the future. One conclusion stands out from these data. The belief in the racial uniformity of an individual's ancestors may be the basic myth of the white man's past.

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SOME CONSTANTS OF TOAD FAT

FRITZ FROMM

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The giant toad, *Bufo marinus*, has become one of the more abundant amphibian species of Puerto Rico since its introduction there more than 30 years ago. It seemed, therefore, the suitable material for a continuation of the author's investigation of amphibian and reptilian fats (Fromm *et al.*, 1954). The pooled fat bodies or livers of animals of both sexes were used either immediately after dissection of the toad or after several days' storage in the freezer. The organs were freed of all adhering tissue, washed free of blood with distilled water, ground with plaster of Paris, and extracted with ethyl ether in a Soxhlet apparatus. Both fats were semisolids, the adipose fat being a cream-colored, the liver fat a brown substance.

The fat constants were determined by the methods used in the study of caiman fat (Fromm *et al.*, 1957), but the saponification value of the liver fat was obtained by Kehren's semimicro method (1952). The amount of nonsaponifiable matter was found by petroleum ether extraction of the saponified fat as described in the work on caiman fat, but for comparison with earlier results (Fromm *et al.*, 1954), ethyl ether extraction of the saponified whole liver was also applied.

TABLE 1

Constants of the fat of Bufo marinus *(average values)*

Organ	Yield % of Organ	M. P. °C.	n^{35}	Saponification Value	Iodine Value	Nonsaponifiable % of Fat
Fat Body	67.3	33	1.475	205.3	58.0	0.74
Liver	7.3	32	1.465	192.4	40.9	1.12

The results are summarized in table 1. The nonsaponifiable matter of the liver fat amounts to 0.06 percent of the liver weight. Previously, it was reported that the nonsaponifiable of the toad liver was 3.2 percent of the liver weight. It was already pointed out at that time (Fromm *et al.*, 1954) that this value was probably too high and caused by ethyl ether extraction of soaps and other material from the saponified liver. This was confirmed by saponifying an equal amount of the same pooled livers as used for the preparation of the oil and extracting it with ethyl ether. The supposed nonsaponifiable in this case amounted to 2.4 percent of the total liver weight, but it was only partially soluble in petroleum ether and gave on repeated resaponification and extraction smaller and smaller amounts of nonsaponifiable. Unfortunately, an accidental loss of the material prevented the final determination of the nonsaponifiable in this way.

The high melting point of both fats is interesting as an effect of the tropical habitat on fat composition and confirmation of the Henrique-Hansen law (Bělehrádek, 1935). The relatively low iodine value corresponds to this high melting point and contrasts with the few data reported for toad and frog fat collected in the temperate zones of Asia, Europe, and South America, and summarized in table 2. It is also worth noticing that analogous to the observations

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on caiman and subtropical turtle fat the iodine value of the liver oil is definitely lower than that of the adipose fat, while Klenk (1933a) found approximately the same iodine value for the adipose and liver oil of *Rana temporaria* in the temperate zone. Further investigation will be needed to see if this unexpectedly low degree of unsaturation of the liver oil is another effect of the Henrique-Hansen law. The other constants are of the same order of magnitude as those reported for reptiles (Fromm *et al.*, 1957) and for the fat of other toads and frogs, cf. table 2.

The help of Mr. Gilberto Pesquera, University of Puerto Rico, Río Piedras, and Mrs. Nereida Planell, Central High School, Santurce, Puerto Rico, in supplying the animal organs is gratefully acknowledged. Thanks are also due to Miss Joan E. Wu, Mount Mercy College, Pittsburgh, Mr. Heriberto Batiz, Mr. William Bracer, and Miss Edicta Franco, Catholic University of Puerto Rico, for their help in some experiments.

TABLE 2

Literature data on amphibian fat

Species	Organ	Yield % of Organ	M. P. °C	n^t	Saponification Value	Iodine Value	Nonsap. % of Fat	Reference
Bufo arenarum	Fat	——	——	——	198	82.6	0.58	Cattaneo and Sutton (1952)
	Body							
B. melanostictus	Fat	——	2.5–13	$1.4660^{25°}$	197.8	77.2	0.47	Tsukamoto and Ohtaki (1951)
	Body							
B. bufo japonicus	Fat	——	——	$1.4647^{40°}$	181.3	104.4	7.94	Tsujimoto and Kobayashi (1921)
	Body							
Rana catesbeiana	Fat	75	−5	$1.4733^{20°}$	192.77	135.38	0.87	Iwamoto and Kisegawa (1930)
	Body							
R. catesbeiana	Fat	4	——	$1.4774^{20°}$	194.78	134.24	1.25	Takasaki and Yamamoto (1930)
	Body							
R. temporaria	Fat	88–93	——	——	——	118–120	——	Klenk (1933b)
	Body							
R. temporaria	Liver	——	——	——	——[1]	115–117	6.7–6.9	Klenk (1933a)

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STUDIES ON THE EFFECTS OF PROGESTERONE ON THE PHYSIOLOGY OF REPRODUCTION IN THE MINK, *MUSTELA VISON*

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Reproduction in mink has been a major problem of the fur farmer since he began raising mink in pens. The two factors which contribute to the difficulty of getting good production are (1) a large number of "misses" or whelping failures and (2) litters of small size.

The mink exhibits a delayed implantation which, according to Hansson (1947), leads to a discontinous embryonic development and a great variation in length of the gestation period. The length of delay in implantation varies widely and seems to be correlated with time of mating. Hansson showed that in mink there is a definite relationship between the date of mating and the length of gestation in that animals that had been bred early had longer gestation periods. This delay in implantation had been observed in other animals much earlier. Bishchoff (1854) reported on delayed implantation in roe deer, *Capreolus*. Fries (1880) recorded a delayed implantation in the European badger, *Meles*. Lataste (1891) discussed five species of rodents in which delayed implantation occurred. Patterson (1913) described the early development of the polyembryonic armadillo, *Dasypus novemcinctus*, and announced a quiescent uterine period immediately preceding implantation.

It appears that this delay could result in a number of conditions which would be disadvantageous to a successful breeding season. The delay may result in death or resorption of blastocysts which could result in a whelping failure or a reduction in litter size.

According to Hansson, if a mated polyestrous animal again came into estrus, this was due either to the egg not having been fertilized or to conditions not being favorable for implantation after fertilization. If implantation does not occur, the characteristic changes accompanying it fail to appear. The fact that a polyestrous animal comes into estrus after mating need not indicate that the eggs from the preceding mating were either not fertilized or were not in a condition for implantation, but may be due to the uterine lining not having been in optimum condition for implantation. Ball (1940) showed that this is often the case with rats, in which copulation does not always elicit corpus luteum activity. with the result that the eggs cannot be implanted although they are fertilized and have developed up to the implantation stage.

Several workers have considered that the delayed implantation is due to a disturbance in the internal secretions, but opinions are very divergent on this point. Some believe that it is caused by too low a production of gonadotropic hormones from the anterior pituitary; some feel that the estrogen production is too low; and still others believe that the corpora lutea do not produce sufficient progesterone.

Since a great deal of work had been done in attempting to overcome the delay in implantation without success, it occurred to this writer that some of the associated phenomena might be changed. It was first suggested by Hammond (1951) that the injection of progesterone after mating might result in an increase in litter size. Since a difference in mean litter size has been observed among different color mutations, it was decided to test the possibility of a genetic deficiency of activity of the corpora lutea linked to the various color mutations. Another

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facet of this problem could be the reduction of the number of "misses" by these injections. In conjunction with these problems would be the study of the histological effects of these injections on the corpora lutea.

MATERIALS AND METHODS

The mink used in this experiment were donated to The Ohio State University by members of the Ohio Mink Breeders' Association. The experiment was carried out over two breeding seasons in order to accumulate sufficient data to be treated statistically.

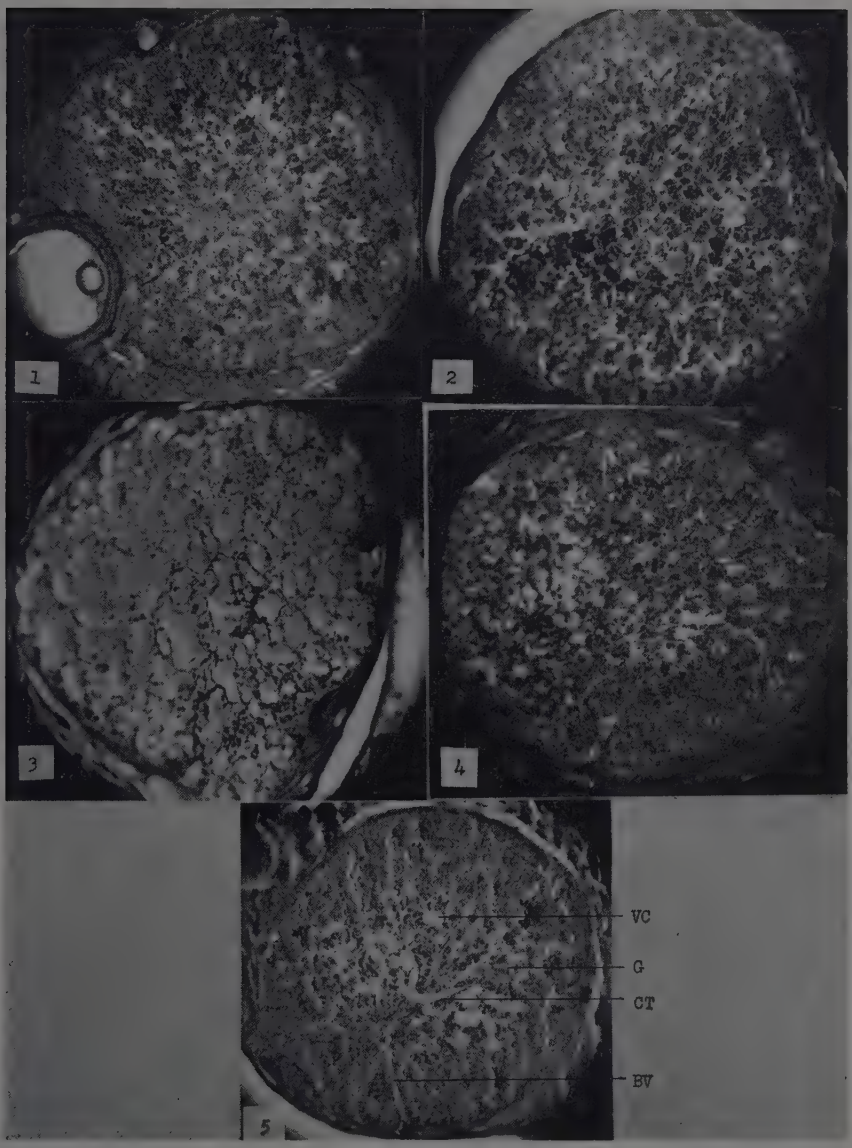
During the first year, animals were treated on four different ranches. The animals treated on two of the ranches consisted of a variety of color phases. These two populations were made up of sapphire, aleutian, pastel, dark, blue frost, white, and silverblu mink and contained kit females as well as older females. One of the other two groups consisted of kit sapphire females, whereas the remaining group contained only kit pastel females. In the latter two groups a single color phase was used in order to determine if a genetic deficiency of progesterone production might be linked with a particular color mutation. In all four experimental groups there were 47 treated animals and 51 control animals. Wherever possible, sisters of the experimental animals were used as controls. The experimental animals were given a single injection of 5 mg of progesterone in oil. The injection was made intramuscularly in the thigh 6 to 8 days after copulation. The time of injection was based on Enders' (1952) and Hansson's work in which they stated that the time elapsed during passage of ova through the tubes was 6 to 7 days.

The following year arrangements were made with various mink ranchers throughout northern Ohio and two ranches in Illinois whereby the writer would furnish instructions and progesterone in return for accurate whelping records. During this breeding season the work was continued at the local mink ranch. The author made all injections on the latter ranch. From the accumulated data, a statistical analysis of the effect of injection on the number of whelping failures was made. In this group there were 1,234 females, 727 being injected with 5 mg of progesterone in oil and 507 used as control animals and not injected. Again, sisters of injected animals were used as controls whenever possible.

In attempting to discover possible effects on the histology of the corpus luteum, a number of animals were sacrificed at various times after breeding and the ovaries were recovered. The animals used in this phase of the experiment also furnished material for another investigator who was making a study of the embryology of the mink. For this reason, the animals were opened and one uterine horn was removed. At a later time these same animals were reopened and the second uterine horn and both ovaries were removed. The operative technique consisted of anaesthetizing the animal by the intraperitoneal injection of 0.35 cm^3 Nembutal Sodium solution, 60 mg/cm^3. Surgical hair clippers were

EXPLANATION OF FIGURES IN PLATE

1. Photomicrograph of a corpus luteum of an injected animal. Actual maximum diameter was 1.9 mm. Note denser peripheral arrangement of granulosa cells and section of a blood vessel in lower right area. At lower left is an ovum in unruptured follicle.
2. Photomicrograph of a corpus luteum of a control animal. Actual maximum diameter was 1.9 mm. Note uniform density of granulosa cells interspersed with few vacuoles.
3. Photomicrograph of a corpus luteum of an injected animal. Actual maximum diameter was 2.2 mm. Note the extreme vaculoation of the entire corpus luteum.
4. Photomicrograph of a corpus luteum of a control animal. Actual maximum diameter was 2.2 mm. Note lack of extensive vacuolation and distribution of vacuoles present.
5. Photomicrograph of a typical corpus luteum selected to show granulosa cells, blood vessels, and general picture of a functional corpus luteum.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then used to remove the fur from the ventral pelvic region. A 1 and ¾ inch incision, performed to the right of the linea alba, provided sufficient exposure of the organs involved. Since the first incision was made to obtain one of the uterine horns for the embryological study, the ovary and oviduct were left intact after the excision of the horn. This excision was accomplished after ligating the major blood vessels supplying and draining the uterine portion to be excised. In the few instances of excessive bleeding the application of a Thrombozyme-soaked cotton swab effected coagulation.

It was found that during the course of the operations strict aseptic practices were unnecessary and were confined to bathing instruments and hands in 85 percent ethyl alcohol. The incised abdominal wall was sutured with surgical thread and the cut edges of the skin were drawn together with metal wound clips. Shackelford (1952) noted difficulty in maintaining surgical closure with thread or catgut due to the animal's tendency to gnaw or claw at the incision area. No difficulty was experienced from this type of behavior after using the metal clips. At a later time, the interval of which was determined by the embryologist, the animal was sacrificed by giving an overdose of nembutal and the remaining uterine horn and the ovaries were quickly removed and placed in Bouin's fixative. The ovaries were removed from the fixative after 48 hours of fixation and stored in 70 percent alcohol. The ovaries were then treated with lithium carbonate solution to facilitate removal of the traces of the fixative (picric acid crystals) and then inbedded in paraffin after treatment in the regular alcohol series. They were then sectioned at 50 μ, and whenever possible, these sections were mounted in serial order. The tissue was stained with Ehrlichs glycerine-alum haematoxylin and counterstained with eosin after which they were mounted in piccolite. The slides were studied microscopically and all corpora lutea were traced from their first appearance in the sectioned ovary to their disappearance from later sections. The corpora lutea were measured at their greatest diameter by using a vernier caliper under 30X magnification. Measurements were made to the nearest one-tenth of a millimeter. The practice of following each corpus luteum through the ovary via the serial sections made it possible to count the total number of corpora lutea. The number of corpora lutea per ovary varied from 0 to 20. Their size varied from 1.4 mm to 2.6 mm. Ten slides were selected at random from those comprising the treated group and ten slides from those of the control group. Photomicrographs were made of the various corpora lutea on these slides in order to compare histologically the corpora lutea in these two groups. Those corpora lutea that were photographed were selected as the largest represented on that particular slide. Plate I shows typical sections of corpora lutea from treated animals as compared to those from control animals.

RESULTS AND DISCUSSION

Effects of treatment on litter size.—During the first year the animals were treated on four ranches with the animals designated as Groups 1, 2, 3, and 4. In Group 1 (U-55) were 8 treated and 7 control animals. The treated animals averaged 4.75 kits per litter; the control animals averaged 4.29 kits per litter. In Group 2 (N-55) 9 treated animals averaged 4.33 kits per litter; 9 control animals averaged 3.0 kits per litter. In Group 3 (G-55) 15 treated sapphire females averaged 4.6 kits per litter; 15 untreated kit sapphire females averaged 3.53 kits per litter. In Group 4 (S-55) 15 treated kit pastel females averaged 5.63 kits per litter; 20 untreated kit pastel females averaged 3.90 kits per litter. These latter two groups were used to test the contention that a genetic link between low corpus luteum activity and color mutation existed. The fact that the pastel animals responded more markedly than the sapphire animals seems to support the assumption that such a genetic link exists.

The following breeding season on the neighborhood ranch (N-56), a mixed

group of fifty-seven treated and thirty-three control animals were used. The discrepancy in the size of the two groups was due to the manner in which littermates were used. Where three females occurred in a litter, two were used as treated animals and the other as a control. The treated animals produced 227 kits, an average of 3.98 kits per litter. The control group produced 67 kits, an average of 2.03 kits per litter.

These data were treated statistically using an analysis of variance. Table 1 shows the results of this analysis for the five groups described above. The F value derived in the first four of these groups was not statistically significant but

TABLE 1

Individual treatment of the five groups showing the derived F value

	Treated			Control			
Group	N	Σx	Σx^2	N	Σx	Σx^2	F
U–55	8	38	256	7	30	142	0.12
N–55	9	39	181	9	27	123	2.37
G–55	15	69	407	15	53	277	1.33
S–55	15	83	523	20	78	434	3.90
N–56	57	227	1155	33	67	259	18.74

TABLE 2

Treatment of four groups as a single group

Treated			Control			Total		
N	Σx	Σx^2	N	Σx	Σx^2	N	Σx	Σx^2
47	229	1367	51	188	976	98	417	2343

Source	*S.S.*	*df*	*M.S.*			
Total	568.62	97		F	$F_{.05}$	$F_{.01}$
Between	34.41	1	34.41	6.18	3.94	6.91
Within	534.21	96	5.565			

in every case there was a definite increase in litter size. The fact that these groups were made up of small sample sizes may account for an F value that was not significant but since there was an increase in litter size each time, the author felt that a statistical test of the combined results should be performed. Table 2 shows the results of the analysis of the first four groups. The F value derived was 6.18. The significant F value for this analysis using the appropriate degrees of freedom is 3.94 at the 5 percent confidence level and 6.91 at the 1 percent confidence level. The nearness of the determined value and the table value prompted still another combination of results. Table 3 shows the treatment of all five groups which yields an F value of 15.99 and the corresponding table value using the appropriate degrees of freedom is 6.77 at the 1 percent level of confidence.

The increase in litter size might be accounted for as being due to a decrease in loss of blastocysts through facilitation of implantation or a decrease in number of blastocysts resorbed. Enders reports that approximately 50 percent of the eggs ovulated fail to implant and are resorbed.

Effects of treatment on number of whelping failures.—That portion of the experiment dealing with the effect of the injection on the number of "misses" was performed during the 1956 breeding season. A total of 1,234 animals was used in this phase. These animals were separated into two groups, the treated group contained 727 and the control group 507. One hundred "misses" occurred in the treated group, 97 occurred in the control group.

The effects of the injection on the number of whelping failures or "misses" supports the idea advanced above concerning the mode of action of the hormone. Since it has been supposed that the injection renders the endometrium more nearly in optimum condition, thereby allowing more complete implantation, it is considered a reasonable conclusion that this is the explanation for the decrease in the number of "misses" in the treated group as compared to that in the control group. If the implantation is more complete, it is logical to assume that there

TABLE 3

Treatment of five groups as a single group

Treated			Control			Total		
N	Σx	Σx^2	N	Σx	Σx^2	N	Σx	Σx^2
104	456	2522	84	225	1235	188	711	3757

Source	*S.S.*	*df*	*M.S.*		
Total	1068.06	187		F	$F_{.01}$
Between	84.55	1	84.55	15.99	6.77
Within	983.51	186	5.287		

is a decrease in possible resorption or abortive blastocysts. The fact that progesterone is necessary for progestational proliferation (Corner and Allen, 1929; Block, 1939) supports this idea. It must be born in mind that progesterone also aids in decreasing uterine motility (Allen and Reynolds, 1935) thereby facilitating implantation and resulting in more complete or "solid" implantation.

The number of "misses" in the treated group was compared to the number of "misses" in the control group and treated statistically by using the chi-square test. This treatment yielded a chi-square of 6.44. This causes us to reject the null hypothesis which states that there was no difference in the proportion of "misses" in the treated group and in the control group. This further means that the value of chi-square obtained in this 2 x 2 table treatment is significant at the two percent level of confidence. Therefore, we would expect a value of chi-square of this magnitude to occur through chance in only two percent of the cases if the null hypothesis were true. Table 4 shows statistical treatment of this phase of the experiment.

Histological effects of treatment.—For this histological study, a survey was made of the slides recording the various conditions observed in each slide. This was

done with complete disregard of whether the slide was from a treated animal or control animal.

These slides were then sorted into two groups: the slides from the treated animals in one group and the slides from control animals in the other. From these slides, ten were selected at random from each group. The corpora lutea were measured on each and a photomicrograph of the largest corpus luteum on each of these slides was made. These slides were then studied again and comparisons were made with reference to the size of the corpora lutea, the degree of vacuolation, the condition of the blood vessels supplying and draining the corpora, and the general condition of the granulosa cells. Typical photomicrographs are shown in figures 1 through 4; figure 5 shows characteristics of corpora lutea mentioned above.

TABLE 4

Effect of treatment on number of "misses"—1956

	Whelped	Misses	
Treated	627 A	100 B	T_3 727
Control	410 C	97 D	T_4 507
	T_1 1037	T_2 197	Total=N 1234

$$\chi^2=\frac{(AD-BC)^2N}{T_1T_2T_3T_4}$$

$\chi^2=6.44$ (Significant at 2% level)
df=1

The comparative histological study demonstrated that in the treated animals the corpora lutea show a greater degree of vacuolation than in the control animals. The granulosa cells were found to be less compact in the interior of the corpus luteum in the treated animals than in the control animals. This condition was also accompanied by a greater degree of vascularization in the corpora lutea of the treated animals. This leads us to infer that the mode of action of the injected hormone is upon either the corpus luteum directly or through the pituitary causing an increase in the production of luteotrophin. This in turn stimulated the granulosa cells resulting in an increase in lipid deposition in these cells which is associated with the incretion phase. The presence of the lipid material in the granulosa cells is correlated, according to Hansson, with the "incretion" or active phase. He described five phases of luteal condition and his description of the "incretion phase" is comparable to that noted in the treated animals. That in the control animals compared to his description of the "resting phase." The granulosa cells of the injected animals were larger and more dense peripherally than those of the control animals. The granulosa cells of the control animals were uniformly distributed throughout the corpus luteum. There was a tendency for the corpora of injected animals to show a greater degree of vacuolation than those of control animals. This was observed through reading the slides in such a way as to be oblivious to whether the slide being read was from a treated animal or a control animal. Even though capillaries were usually visible infiltrating the

corpora of both the treated and control animals, there seemed to be a greater overall development and establishment of these capillaries in the corpora of the treated animals. The observation or visibility of the capillaries became increasingly more difficult as the degree of vacuolation advanced beyond a general distribution among the granulosa cells. In a number of slides, the corpora of the control animals were found to be infiltrated with spindle-shaped connective tissue cells. This infiltration is accompanied by the capillary network formation. The most striking difference between corpora of injected animals and those of control animals was the fact that the granulosa cells were less dense in the central portion of the corpus of the former. This seems to be correlated with the onset of activity of the central granulosa cells resulting in their increase in size thereby causing that area to have less nuclear material in relation to the amount of cytoplasm. This allows more light to pass through this area giving the impression of less density.

SUMMARY

Bred mink were given a single intramuscular injection of 5 mg progesterone in oil 6 to 8 days after the second breeding. This injection of progesterone causes an increase in litter size. This increase is more pronounced in some color mutations than others. The progesterone caused a decrease in the number of "misses" or whelping failures and caused histological changes in the corpus luteum.

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ROCK MILL

WILBER STOUT
Route 3, Rock Mill, Lancaster, Ohio

When the pioneers came across the Appalachian Mountains into the western part of the Allegheny Plateau, or more definitely into Fairfield County, Ohio, they found the rolling, glaciated, hill country well wooded and abounding with running streams fed by clear, cold springs. Massive sandstones, much weathered and reduced, formed many of the ridge crests. Along a few streams in this area such rocks were eroded to deep gorgelike valleys, the result of natural forces and extended time. Such sylvan nooks abounded with plant life of many kinds. Here mosses, ferns, lichens, liverworts, and other low forms were shaded by huge hemlocks, elms, maples, and other large forest trees. In addition, animal life, especially birds, was pleantiful.

In years past the Moundbuilder once made his home in this country and left his silent, mysterious mounds as mute evidence of his existence. When first explored by white man, this part of Fairfield County was the home land or territory of the Wyandot Indians, a part of the great Shawnee confederacy. A small band of Wyandots still lived at what is now Hookers and another, under chief Tobey, camped just northwest of Royalton.

Of chief interest is the gorge and upper falls of the stream in southeast Section 25, Bloom Township, Fairfield County. The name "Hock Hocking" was given to the stream by the Wyandot Indians because of the natural resemblance of the gorge to a gourd or bottle. The bowl of the gourd is the large basin at the mill and the neck is the restricted gorge above the falls. Rather odd too that the upper falls of the Hocking River at Rock Mill and the lower falls at Logan are both in the same extension rock formation. The lower falls is over the upper part of this thick sandstone, whereas the upper falls is over a basal portion of the same stratum. The large basin below the upper falls is eroded to a depth of 48 feet or more and to a width of two or three times this dimension. At the mill the stream turned a 26 foot over-shot wheel. The neck of the gourd is the constricted gorge above the falls varying from four to forty feet in width and from 20 to more than 40 feet in depth.

The name "Blackhand" was applied by Hicks in 1878 to a shelter rock on the Licking River near Hanover. On the wall of this overhanging rock the Indians had painted a large blackhand with a black pigment. This figure was supposedly a marker for the flint quarries on Flint Ridge in Licking and Muskingum counties. Later the name Blackhand was applied regionally to the formation. To the oil driller, however, this member is known as the Big Injun sand, after a discovery well on Big Indian Creek in West Virginia.

On the outcrop in Ohio the Blackhand sandstone, from 50 to 250 feet or more in thickness, extends from the Hocking-Vinton County line on the south to above Mansfield, Richland County, on the north. Under cover this massive stratum continues southeastward into southeastern Ohio and extends far into West Virginia. In texture the rock is a coarse-grained sandstone, pebbly in many places; and its color varies through shades of gray, pink, buff, and brown. The chief bonding component is some form of iron oxide. This rock is of marine origin, usually it is definitely marked by lenslike patterns of sand found along the seashore. In this locality the dip of the formation is not far from 20 feet to the mile east and twelve feet to the mile south.

The Blackhand sandstone and associated rocks at Rock Mill belong in the Waverly series of the Mississippian system. As these rocks were laid down in

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the ocean and then elevated to a land mass in late Permian time, they have suffered weathering and erosion through several geological ages. Consequently, they are now reduced to hills and valleys with a few hundred feet of relief. Locally, on the outcrop, through differential weathering, resistant layers form bold escarpments, outstanding monadnocks, as at Mount Pleasant, and deep gorges, as at Rock Mill.

The long degradation cycle from Permian time may be divided rather definitely into two parts as follows:

(a) *Gorge below the falls.* The first erosion and weathering period, which accomplished much, extended from the emergence of the land above the sea in late Permian time to the time of the first glacier, the Nebraskan. This ice sheet destroyed the Teays drainage system and inaugurated the Deep Stage. However,

FIGURE 1. The Rock Mill. Photo by Youngstown Sheet and Tube Company.
FIGURE 2. The gorge above the falls. Photo by Theresa Stout.

during this long period of change, which reduced the Allegheny Plateau to hills and valleys, resistant layers held up ridge crests, like Chestnut Ridge to the north, and produced bold escarpments and deep gorges like the so-called cave region of the Hocking Valley. At Rock Mill this level of reduction is quite definitely marked by glacial grooves near the Stout home and by a large pegmatite granite boulder at the corner of the Alspach garden, not far from the mill. Both markers are not much more than 990 feet above sea level. In this area the evidence for the Nebraskan glacier is afforded by the till sheet which is largely weathered away, and by the widely scattered large boulders with some smaller resistant debris. At Carroll the floor of the old Groveport River of Teays age stands at an elevation approximating 650 feet above the sea.

In the massive rocks of variable strength, such as the Blackhand, differential weathering and erosion cause the hard layers to form the rimrock of rugged bluffs, bold escarpments, and deep gorges. In such a variable deposit small

streams cut deep gorgelike valleys like Conkle Hollow, Cedar Falls, Old Man's Cave, Ash Cave, and others of the Hocking Valley. The gorge below the falls at Rock Mill is only an extension of such work farther south. Hence, it was fashioned largely by the various forces of nature during the long period from the Permian uplift to the advent of the Nebraskan glacier.

(b. *Gorge above the falls.* Since only one glacier, the Nebraskan, passed over the Rock Mill area, the time of cutting the narrow gorge above the falls may thus be considered to begin with this ice invasion and to continue to the present. However, some work was done before this time by small streams in a limited basin. The headwaters of what is now the Hocking River formerly belonged to a Deep Stage stream that flowed northeastward through southeastern Section 24, Bloom Township, and diagonally across Section 19, Greenfield Township, to the north-flowing Lancaster River. The Illinoian or the Wisconsin drift sheets, or both, then filled this stream passage with debris and caused the present stream, the Hocking River, to be diverted through a new way to Rock Mill.

This later stream is thus largely responsible for the cutting of the gorge above the falls at Rock Mill. Here the gorge is generally narrow, fairly deep, and about a quarter of a mile long. From the hard rock, bearing the glacial grooves near the Stout residence, to the rock floor of the stream the depth of the gorge is close to 35 feet; under the bridge, just above the falls, it is near 20 feet in depth and so narrow in one place that boys jump from one wall to the other. The upper restricted gorge is cut mainly in strata above the rimrock of the lower broader gorge and thus displays its geological youth. Hence, the two gorges are different in age but similar in workmanship, both resulting from the degrading forces of nature.

Some form of falls has been active for a long time in the Rock Mill area. This fact is evident from the outline of the gorge there, approximately one mile in length. This depression was cut by the headward migration, through falls and rapids, of the excavating powers of small streams through massive rocks. Such work is exceptionally well shown by the many gorges and falls in the Blackhand formation of the Hocking Valley and by that master one, the gorge and falls of the mighty Niagara River. Such accomplishments are referred to as sapping. The causes consist essentially of the direct scouring action of boulders, sand, silt, and rubble passing over the precipice; of loosening of rock particles through solution by water; of chemical changes such as oxidation and hydration of bonding components; of the direct action of plant life on rock surfaces bathed by water or by humid air; of the natural resistance of the rock's texture, whether hard or soft; and of such weather factors as freezing and disiccation.

With just a small flow of water over a falls, these many forces acting together in time will eventually dig and widen a valley to gorgelike proportions. At Rock Mill the large gorge, that below the falls, is the result of such degradation through several geological ages. However, at this place there is a good example of these forces starting to work where the water of the Alspach spring crosses the road and pitches over a low falls into the restricted gorge of the Hocking River. Here a minature and youthful falls is starting to dig its way to a gorge of small dimensions. At this place most of the forces of excavation listed above are quite apparent.

The present falls at Rock Mill, seen from the bridge, is about 14 feet in height and both falls and swift rapids around 20 feet. However, from the position of the pool and the depth of the pit the stream evidently once pitched from the rimrock at a height of forty or fifty feet. Now, during flood stages, the waters of the stream are really hurled from the higher level and descend into the basin below with violent boiling and swirling. Nature as seen at Rock Mill is thus a wonderful worker when given forces and time.

The headwaters of the Hock Hocking River is, as generally considered, in a

spring on the Silas Alspach farm nearly one mile north and west of Greencastle in southeast Section 16, Bloom Township, Fairfield County. Following the meandering of the stream, the distance from the spring to the falls at Rock Mill is close to six miles but in a straight line only four miles. The entire basin above the falls is less than four square miles in extent and lies almost entirely in southeastern Bloom Township. At the falls the stream is constant, never known to be dry. The water during normal flow is from springs, and during the warm weather of July and August it is slightly cool for wading. Also of importance in the region of the thick Blackhand sandstone, the supply of rock water is abundant and is of high potency.

A feature that attracts attention and causes comment is the deep pool below the fall and adjacent to the mill. This pit in the rock was worn by the impact of boulders, sand, and other debris that came over the falls with sufficient force to abrade the sandstone floor to a deep depression. At one time the falls was evidently much higher than it is at present; assurdedly the water pitched from the rimrock some 48 feet or more above. Also, when the dam was in place and when the force of the water was sufficient to keep the pool clean, the millers reported the depth to be about 40 feet. Boys swimming in the pool now state that bottom is reached at 12 or 15 feet. The water in the pool is always cool as it is supplied partially from nearby springs.

In the gorge at the edge of the pool and on the mill side of the basin is a fine spring formerly used for household purposes. The water was drawn by letting a bucket down on a cable from the opposite rim of the gorge. The bucket, properly weighted, filled when lowered to the spring and then, filled, was returned by a windlass. The spring still pours its stream of water from a master joint or open crack in the massive rock.

The stone used in the foundation of the mill was taken from a quarry not far distant down the stream. The material used is from the rimrock where the stone is well bonded by iron oxides and is quite strong, very durable, and weather resistant.

(In this article much data were supplied by Mrs. Millie Dildine Alspach, now deceased, and many measurements were made by Willard and Florence Betz.)

Concerning Rock Mill, really named for the rocks at this scenic spot, Scott says, "Joseph Loveland and Hezekiah Smith, both New Englanders, erected a log grist mill at the upper falls of Hocking, now called Rock Mill. This was the first mill built on the Hocking. It was set low down among the rocks. The grists were taken in at the gable-end and let down to the hopper with ropes and then raised to the level by the same means. The mill was on the old Columbus-Marietta road, seven miles from Lancaster. These men are said to have sold goods at their mill which were brought by pack-horses from Detroit. Also as late as 1822, it is said, there were no grinding facilities in Bloom Township besides one small raccoon-buhr mill" (1877).

Some data on the living conditions of that time are also supplied by Scott, "The settlers subsisted principally on corn bread, potatoes, milk and butter, and wild meats. Flour, tea, and coffee were scarcely to be had, and when brought to the county, such prices were asked as to put it out of the power of many to purchase. Salt was an indispensable article and cost, at the Scioto Salt Works (Jackson) $5.00 for fifty pounds; flour cost $16.00 per barrel; tea $2.50 per pound; coffee $1.50; spices and pepper $1.00 per pound."

Some additional notes are supplied by Howe, "This log mill was built in the basin below the falls and around 1820 was washed out by a flood It was powered by an overshot wheel. The present mill now standing, [1958] was built in 1824 and powered by an overshot wheel, 26 feet in diameter" (1908).

Aside from Loveland and Smith, Rock Mill in its many years of existence passed through several hands. "The next owners were Christian Morehart and

Joseph Knabenshue; then Philip Homrighous; then John Foor. In 1899 the mill was remodeled, a turbine was installed over the falls, replacing the ancient water wheel. The turbine proved unsatisfactory so they changed to steam power. The remodeling was done by Marion Solt, John Foor, and two Alspach brothers, Edward and Jacob. A Mr. Talley was the next owner. He was bought out by J. P. Gundy and F. H. Barlow. The mill then passed to W. S. Alspach. It went out of business about 1905" (Mary and Urcel Alspach, present owners).

In the early days a saw mill was operated by the mill owners about one-fourth mile above the falls. From lumber still around, the crosscut saw operated vertically and the boards were split off from the end of the log. Nearly one mile downstream from the falls a woolen mill operated for many years. Its specialty was blankets.

The mill is built with three main floors, above the rim of the gorge, for the general milling and care of the grain and with two floors below this, within the basin, the upper one for the buhr-stones and their operation and the lower one for the motive gearing necessitated by the water wheel. An opening from the lower floor led to the catwalk and on to the flume and the dam. The general dimensions of the mill as now determined are 34 feet wide, facing the gorge, 38 feet long, and 70 feet high. The timbers for the framework are mainly hand-hewn oak, cut from straight, clear logs. The posts, 16 in number, four full height for each side, and four short ones for the first floor, are 12 x 12 inches in size. Both the corner and wall posts are substantially braced for strong rigid support by 4 by 6 inch timbers. The massive plates that span across the mill are also hand-hewn oak, 14 inches wide by 12 inches thick and 32 feet long. The plates for the first floor are supported by posts, but those on the second and third floors span the entire mill, thus leaving large unrestricted rooms for the spacing of the various milling machinery and storage bins. The framework of the mill is in four bends, for carrying both the lateral and vertical finishing parts. The joists are mainly 3 x 10 inch x 14 feet long, spaced on 4 foot centers. The studs for holding the siding and windows are of 4 by 4 inch material securely mitered into the sills and plates. The weather boards, chiefly yellow poplar and hemlock, are 7 inch wide by ½ inch thick and still serviceable. The flooring throughout the mill is tongue and grooved, 1 and ⅛ inch thick and is of various widths up to 17 inches and of different lengths up to 22 feet. There are nine windows on a side with frames 31 and ½ by 56 inches.

The grinding operation for the primary milling of the grain was done on the sub-floor of the mill. This is really within the basin of the gorge and is securely framed by heavy timbers, having floor space 12 by 6 feet which contains the buhr-stone and gearing to the water wheel. The coarse grinding buhr is 42 inches in diameter and the lower or fine grinding buhr 48 inches. Each is approximately 12 inches thick. These stones are of cellular flint, probably fashioned at McArthur.

The distance from the main floor of the mill to the rock floor of the gorge is close to 48 feet. The mill race cut through the solid sandstone is about 30 inches in width and 22 feet deep. The dam constructed of heavy timbers was anchored into the walls of the rock just above the brink of the falls. The mill pond thus created was small, only some 35 rods long, but as the stream was continuous, its supply through much of the year was sufficient for grinding.

Most certainly this mill was constructed by millwrights thoroughly familiar with such work. They understood the principles of framework and the value of braces, mortise, and tenon and pinning for strength. Thus, the building was bonded into a rigid mass to withstand the vicissitudes of the natural elements for many years. Good forest timber was plentiful at that time (1824); but today (1958) we ask who felled the trees, who scored the logs, and who wielded the broadax to fashion such structural material? The old mill is still of much interest.

The first buhr stones used in Rock Mill, from 1799 to 1820, were probably of French derivation or from local quarries in eastern Pennsylvania. Those after 1824, referred to as raccoon buhrs, came from the Raccoon Creek basin in central Vinton County. At McArthur the production of buhr stones began as early as 1807. Another possible source was the flint rock on Flint Ridge in Licking and Muskingum counties. The deposits in both places belong on the Vanport horizon, usually marked by a few feet of gray limestone.

Rock Mill, with its mighty beams of hand-hewn oak, and with the sound of the splashing water as it poured over the water wheel, served, for many years, a very useful purpose to the countryside. There, grists were ground; also in the interim, news was dispersed and, in season, bathers enjoyed the cool waters of the deep pool. Now the rugged rocks, tumbling falls, weathered mill, and covered bridge form a scenic spot for viewers, photographers, and artists. The rocks still stand for the supremacy of nature and the mill as an emblem of former days.

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Learning and Instinct in Animals. *W. H. Thorpe* Harvard University Press, Cambridge, Mass. 1955. viii+493 pp. 9 pl. $10.00.

The material in this book is divided into three sections. Section I deals with directive and purposive behavior in relation to the theory of instinct. Section II is concerned with the types of learning and with their relationships, and Section III is a comparative study of learning abilities and behavior in the various animal groups. Section III, which covers 251 pages in itself, contains a most valuable review of the behavior characteristics of the major animal groups. Here the author has brought together, from the interminable mass of experiments on behavior, a core of documented examples which give some reasonable concept of the variation and scope of behavior in animals. Sections I and II deal with the theoretical aspects of instincts, drives, releasing mechanisms, habituation, conditioning and learning theory. Various points of view are given and evaluated. The discussion is well illustrated by means of references to the specific experiments by many outstanding workers in the fields of zoology and psychology.

No one book could cope with the entire field or bring agreement among the various theorists nor does Dr. Thorpe claim to do this. He has done an excellent job of organizing and bringing into focus some of the major behavior problems. Judicious use of this book along with other major references in comparative behavior can go a long way in clarifying the issues.

L. S. Putnam

Weather Analysis and Forecasting. Volume II. Weather and Weather Systems. *S. Petterssen.* McGraw-Hill Book Company, Inc., New York. Second Edition, 1956. xii+266 pages. $6.00.

The post World War II advances in both the theory and technique of weather forecasting are reflected in the second edition of this well known text for meteorologists. Petterssen believes that machine-made forecasts will eventually replace conventional methods. Thus, most of Volume I, Motion and Motion Systems (Chapters 1–19), consists of an introduction to the analytical tools needed for the interpretation and prediction of air movements.

Volume II continues with a description of other atmospheric factors which are important in weather analysis. Among the topics discussed are air mass production and transformation, temperature and humidity relationships in the atmosphere, clouds, precipitation, mist, fog, convective clouds and associated weather. Much of the material has been rewritten and many references to recent work are included, as for example in the section on thunderstorms where extensive reference to the work by Byers and Braham is made. The 9 chapters in Volume II also include one by J. C. Thompson on quantitative precipitation forecasting and a concluding one by T. F. Malone on the application of synoptic climatology to weather prediction.

This new edition is an excellent introduction to weather and weather forecasting and is highly recommended to those desiring a more than superficial approach to the subject.

John H. Shaw

LIGHT-SCATTERING, INTRINSIC VISCOSITY, AND GOLD NUMBER RELATIONSHIPS FOR SOME DEXTRAN FRACTIONS

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The usefulness of clinical dextran is dependent upon the size of its molecules, which can be decreased by degradation or obtained directly by controlled fermentation as reported by Grönwall and Ingelman (1945), Stacey and Pautard (1952), Ingelman (1948), Whiteside-Carlson (1952), Wolf *et al.* (1953, 1954), Stacey (1951), Lockwood *et al.* (1951), Hamdy *et al.* (1956), Nadel *et al.* (1953), Spendlove (1953), Koepsell *et al.* (1953), Hehre (1953), and Tsuchiya *et al.* (1952, 1953, 1955).

Several physico-chemical experiments on dextran have been reported in the literature to establish the molecular properties of this polysaccharide (John *et al.*, 1954). Ingelman and Halling (1949) used viscosity measurements, ultracentrifugation, diffusion and adsorption experiments to characterize some dextran fractions with respect to their molecular weights. They established the following linear relationship between intrinsic viscosity and the molecular weight (M) for some partially acid-hydrolyzed dextran fractions in the intervals $40{,}000 < M < 300{,}000$:

$$[\eta] = 8.2 \times 10^{-7}\ M + 0.18$$

Wales *et al.* (1953), studying the intrinsic viscosity-molecular weight relationship for acid-hydrolyzed dextran produced by *Leuconostoc mesenteroides* B–512, used the sedimentation equilibrium method in order to obtain a measure of the polydispersity of the fractions as well as a weight-average molecular weight. They established the following relationship between the intrinsic viscosity $[\eta]$ and the weight-average molecular weight for some dextran fractions in the range of $20{,}000 < M < 250{,}000$:

$$[\eta] = 10^{-3} \times M^{1/2}$$

Wolff *et al.* (1954) established the following relations between the inherent viscosities and the molecular weight (M_n and M_w):

$$[\eta] = 8.85 \times 10^{-4}\ M_n^{0.528}$$

and

$$[\eta] = 2.03 \times 10^{-3}\ M_w^{0.431}$$

Physico-chemical studies involving measurements of molecular weight using intrinsic viscosity and light-scattering measurements are presented here for dextran fractions and subfractions produced through acid, enzyme and ultrasound degradation of high molecular weight dextran produced by *Leuconostoc mesenteroides* B–512 and 683. The protective characteristic of these dextran fractions was also investigated using gold number measurements. This gold number is the weight of the protective substance (in milligrams) which is just insufficient to prevent a change in color of 10 ml of a red gold solution when 1 ml of 10 percent sodium chloride is added to it. The relation between the gold number of some dextran fractions and their molecular weight as measured by the intrinsic viscosity was also investigated and correlated.

MATERIAL AND METHODS

Production, Degradation and Fractionation of Dextran

Leuconostoc mesenteroides B–512 and 683 cultures were used for the production of dextran using the following sterile medium (pH 7.2): sucrose 150.0 gm, acid hydrolyzed casein 5.0 gm, K_2HPO_4 5.0 gm, yeast extract 1.0 gm, NaCl 2.0 gm, and $MgSO_4$ 0.022 gm per liter of distilled water.

After inoculation and incubation of the culture medium at 25°C, the dextran polymer was precipitated after clarification, effected by filtration through bacterial filters, using 99 percent isopropyl alcohol (Hamdy *et al.*, 1954). Degradation of the high molecular weight dextran, achieved through acid, enzyme and ultrasound, was followed by fractionation experiments of the degraded polymer as previously described (Hamdy *et al.*, 1956).

Measurements of dextran concentrations.—Dextran concentrations used in this study, except for gold number, were determined with the B–S differential refractometer.

Intrinsic viscosity measurements.—The intrinsic viscosities of the dextran fractions and subfractions were determined using a Fenske modified Ostwald viscosimeter No. 50, and concentrations between 0.2 and 0.6 gm/dL. at 25°C ± 0.05.

Light-scattering.—The light-scattering studies for molecular weight measurements were made using the B–S light-scattering photometer designed by Brice *et al.*

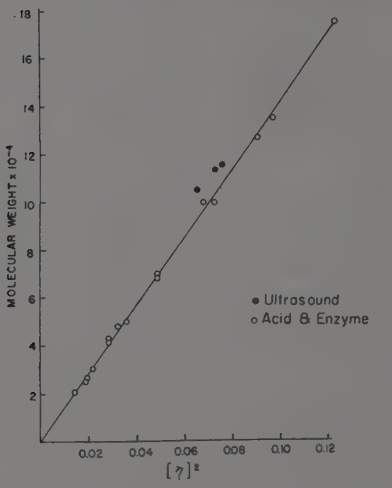

FIGURE 1. Relationship of the weight-average molecular weights to the square of the intrinsic viscosities of the dextran samples.

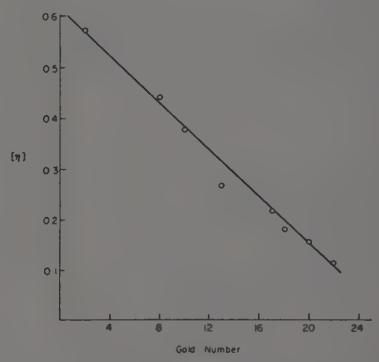

FIGURE 2. The relationship between the intrinsic viscosities and the gold number values of various dextran fractions.

(1950). Slight amounts of dust particles scatter light considerably and give rise to erroneous results. Consequently, the dextran solution was filtered through an ultrafine sintered glass filter into a dissymmetry cell and light-scattering measurements were made at 0, 45, 90, and 135 degrees for both blue and green light to obtain values for both turbidity and dissymmetry, Z ($Z = i\ 45° / i\ 135°$). No correction for depolarization of the scattered light was made in this study. Dissymmetry values were in the range of 1.1 to 1.2 for the samples investigated.

Gold number. For the determination of the gold number, the dextran sample was first placed in a 56°C oven and dried to constant weight. Aqueous solutions of 1, 2, and 4 percent of the dried dextran were made. The range of the protective colloid of each concentration was determined using 0.01, 0.1 and 1.0 ml of the

[1]Prepared according to the formula of the United States Army Dept. Technical Manual 8–227 method for preparation of colloidal gold. (Chlorauric acid was reduced with formaldehyde.)

aqueous solution, added to test tubes containing 10 ml of gold hydrosol.[1] The tubes were immediately shaken for 3 minutes and 1 ml of a 10 percent aqueous solution of sodium chloride was added to the mixture while stirring. The gold number, which is the weight of the dextran in milligrams which will just fail to prevent a change in color from red to violet, was then calculated.

RESULTS AND DISCUSSION

Light Scattering-intrinsic Viscosity Relationship

Twenty samples of dextran were used in this study. They were fractions and subfractions of samples previously depolymerized by different procedures, namely: acid, enzyme and ultrasound (Hamdy *et al.*, 1956). The intrinsic viscosities of these twenty samples and their weight-average molecular weight as measured by the light-scattering are recorded in table 1. When the molecular weight of these samples were plotted against the square of their intrinsic viscosity (fig. 1), the data conformed to a straight line, over a molecular weight range of 20,000 to

TABLE 1

Intrinsic viscosity values and the corresponding weight-average molecular weight of some acid, enzyme and ultrasound degraded dextran fractions and subfractions

Type of Degradation	Strain No.	Sample No.	$[\eta]$	$[\eta]^2$	Molecular weight[1]
Acid	683	F_2, b	0.360	0.1296	179,000
		F_2, c	0.310	0.0961	135,000
		F_3, c	0.280	0.0676	100,000
		F_4, c	0.220	0.0484	69,000
		F_5, d	0.190	0.0391	45,000
		F_5, g	0.170	0.0289	43,000
		F_6, f	0.140	0.0196	27,500
	B-512	G_1, b	0.300	0.0900	127,000
		G_1, c	0.220	0.0484	70,000
		G_3, a	0.170	0.0280	42,000
		G_3, b	0.150	0.0225	31,500
		G_4, c	0.140	0.0196	27,000
		G_3, c	0.120	0.0144	21,000
Enzyme	B-512	E_1, b	0.580	0.3364	500,000
		E_1, d	0.350	0.1225	175,000
		E_3	0.270	0.0729	100,000
		E_4	0.180	0.0324	48,000
Ultrasound	B-512	U_1, c	0.275	0.0756	116,000
		U_2, a	0.270	0.0729	114,000
		U_3	0.250	0.0625	105,000

[1]Weight-average molecular weight measured by light-scattering.

180,000. The slope of this curve was calculated and the equation representing the relation between intrinsic viscosity and molecular weight was found to be:

$$M = 1.42 \times 10^6 \times [\eta]^2$$

$$[\eta] = 8.39 \times 10^{-4}\ M^{1/2}$$

All the M values of these different fractions of dextran 683 and B-512, followed this relationship except those of the ultrasound depolymerized samples, which showed lower intrinsic viscosities for comparable molecular weights. It appears that the ultrasound fractions and subfractions have intrinsic viscosities which are lower for a given molecular weight than provided for by the above equation. This may throw some further light on the mechanism of the degradation of dextran by the ultrasound (Hamdy *et al.*, 1956). The starting material before depolymerization is in all likelihood made up of large rodlike structures which are

essentially bundles of dextran chains held together in a compact arrangement. It is believed that acid hydrolysis and enzyme degradation (Hamdy *et al.*, 1954) cause these chains first to unfold and then to break along the glycosidic linkage, while ultrasound does not unfold the chain but fractures the bundle of chains at bonds other than the glycosidic linkages probably carbon to carbon bonds and results in compact fragments which would exhibit lower intrinsic viscosities than the chainlike structures of acid and enzyme hydrolyzed dextran.

The relationship obtained in this investigation for $[\eta]$ vs M gives intrinsic viscosities which are lower than those given by the relationship of Wolff *et al.* (1954) by 10 percent in the 100,000 molecular weight range and by 20 percent in the 20,000 molecular weight range. A 10 percent difference is within the experimental error of the light-scattering measurements.

TABLE 2

The gold number-intrinsic viscosity relation of dextran B–512

Sample	$[\eta]$	*Gold number* mg
Acid hydrolyzed	0.135	22
Ultrasound	0.160	20
Ultrasound	0.200	18
Acid hydrolyzed	0.220	17
Acid hydrolyzed	0.270	13
Acid hydrolyzed	0.380	10
Acid hydrolyzed	0.440	8
Enzyme	0.560	2

Gold Number and Intrinsic Viscosity Relationship

The protective action of various dextran samples having different intrinsic viscosities (molecular weights) was studied. The relation between the gold number and the degree of polydispersity of some dextran fractions and subfractions was also investigated. Approximately 400 separate gold number determinations were made on 60 dextran samples of different intrinsic viscosities representing first, second and third fractionations of acid, enzyme and ultrasound degraded dextran B–512 and 683.

The gold number and intrinsic viscosity of some homogeneous dextran subfractions produced by *L. mesenteroides* B–512 are recorded in table 2 and in figure 2. While it was relatively easy to differentiate between samples of widely different intrinsic viscosities (or molecular weights) by means of gold number measurements, gold number values for samples with intrinsic viscosities which differ by only a few percent were variable and did not correlate well with the intrinsic viscosities.

It was also observed that the more homogenous the dextran, the higher the gold number, while a heterogenous sample of approximately the same intrinsic viscosity had a lower gold number; *i.e.*, a high protective action. Jirgensons (1951) studied the protective action of various fractions of polyvinylpyrrolidone (PVP) on sliver sols and found that the lower molecular fractions of PVP had a greater protective power than the very high molecular fractions.

SUMMARY

Twenty different samples of fairly homogenous type dextrans resulting from three different procedures of degradation were used for molecular weight measurements. Using the light-scattering measurements, the relation between the

intrinsic viscosity of the samples and their weight-average molecular weight was found to be a straight line function in the range between 20,000 and 180,000:

$$M = 1.42 \times 10^6 \times [\eta]^2$$

or

$$[\eta] = 8.39 \times 10^{-4} M^{1/2}$$

All the weight-average molecular weight values of these different samples followed this relationship except those of ultrasonically depolymerized dextran which fall just a little above the curve. This may be due to a fundamental difference in the flexibility and configuration of the dextran molecule. The protective action as measured by gold number of 60 dextran fractions was investigated. No close correlation between gold number values and either molecular weight or the degree of polydispersity was found.

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THE EFFECTS OF WEATHERING AND OTHER CHANGES AT NELSON LEDGES STATE PARK[1]

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Alterations in topography due to weathering, if they can be satisfactorily demonstrated, are enormously useful to teachers seeking to connect the passage of time with geologic change. Even the more imaginative students in geology experience some difficulty in adjusting time-consciousness to the extended periods required to account for gross changes in topography. Students display new comprehension on seeing weathered limestone monuments and spectacular waterfalls like those at Niagara. But prominent features, including waterfalls, erosion along lake fronts with unprotected headlands, and even rainwashed gullies, often fail to convey the significance of the other side of the coin, the infinitely slower land-leveling process which occurs over a greater percentage of the terrain.

The author, while teaching general geology in northeastern Ohio, had occasion to witness the effects of his own overenthusiasm to emphasize rapid erosional forces. When taking students first to a waterfall and later to Nelson Ledges south of Parkman, Ohio, to see the well-known tumbled rocks there, he observed that the huge blocks at the Ledges were immediately (and incorrectly) presumed by students to have moved into their present positions much more recently than closer study revealed.

In the first locality, known as "Forty Foot" Falls (41° 17' N–81° 10' E), just south of the Erie Railroad right of way, 2.9 miles east of Mantua, Ohio, the more spectacular conditions bringing about land-leveling in a young valley were viewed. To add to the inherent sense of rapid change conveyed by the slabs of sandstone at the foot of the falls, a fortuitous rockfall took place during the years this spot was visited; photographs of the cliff before and after the rockfall intensified the lesson.

It was natural, therefore, that students visiting Nelson Ledges State Park, with its gigantic blocks of Sharon conglomerate pitched outward from the mother rock, would translate by analogy (and falsely) the changes there as having taken place "in probably a few hundred years or at most a few thousand."

Stereo-photographs.—Estimating the time at which the blocks were an integral part of the mother rock, or the time they began their downhill slippage, was necessarily based almost wholly on conjecture until a fortunate circumstance offered a moderately tangible means of calculations. An elapsed time of fifty years from which to extrapolate the duration of postglacial times, estimated to be between 11,500 and 20,000 years, is too small to allow for errors of judgment if not measurement; but the observations of the effects of weathering and other changes made with the help of old photographs serve to nullify the hypothesis that rapid slippage is now occurring, and may be of later use to geologists with the passing of the years.

Following a talk given before the Portage County Historical Society, the author was loaned a collection of about forty stereo-photographs treasured as souvenirs of the picturesque Ledges in times past, along with a viewer common in parlors of an age gone by. (These are to be placed in the archives of the historical society by their owner, Mr. Cyrus Plough, of Ravenna, Ohio.) By trial and error the writer and two of his students, Russell Jackson and Miss Jane Corbin, whose work at the Park culminated in the inclusion of their map in a guidebook now available at the park, were able to locate precisely the positions of the stereo-

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camera years before. Thus was presented an effective means, within certain limitations, of studying the relative positions of the blocks on the slope at close range, as well as studing the changes, whenever present, in the pathways, vegetation, rock surfaces and the interior of the interesting cave.

The ledges, past and present.—For those unacquainted with the locality, a brief description will serve to show the prospects offered by old, stereoscopic photographs.

The Ledges represent an upper portion of palisades on the west side of the formerly wide and deep Grand River Valley. Filling by glacial sand and till has almost obliterated this ancient valley. Leverett (1902) gives depths to bedrock near Ashtabula and elsewhere in the Basin, and these permit an estimation of nearly 300 feet of fill now occupying the once impressive gorge. To the east a mile away, Kennedy Ledges, recently added to State Park property, rises as a complement of the west bank, or more likely as an island once resembling in general features the much larger towers in the Grand Canyon of the Colorado (Pettit, 1954). It may be assumed that the sides of the valley were fairly steep and that the massive blocks at one time may have crashed, rather than slid gently, in their trips downhill. The exposures of Sharon conglomerate which compose the Ledges proper extend north and south a mile or more from the central scenic point opposite which the old inn was built. It is pertinent to this account to mention that the signal features at the Ledges lie almost exactly on the St. Lawrence-Mississippi Divide, and as a consequence there is almost a minimum of postglacial erosion from the front of the palisades at the locality being described. Behind the Ledges to the west the terrain rises a hundred feet higher in less than a mile, but surface water drains predominantly away from the Ledges at the inn, and not across in front of it.

At some time or times in the past, large chunks of channel-deposited conglomerate parted from the mother rock, shifting eastward downhill. They are now disarranged in a jumbled confusion, with caves and narrow passageways between. Their bases are, for the most part, deeply buried in debris. The eastern edge of the block furthest from the mother rock is about sixty yards from it; between the furthest block and the mother rock there are intervening blocks which aggregate about thirty yards, horizontal distance. The remaining thirty yards, therefore, comprise the distance the furthest block observable has traveled from its presumed point of origin. By visually comparing opposite faces of intervening blocks, there is adequate evidence that very little material has scaled off, and that if some has done so, an unlikely uniformity of scaling over large areas took place.

The question arising is this: How much shifting of the blocks may be presumed to be transpiring in the immediate past and in the present, and how nearly do the blocks occupy positions they had ten to twenty thousand years ago?

If the present position of the great chunks of stone, some of them fifty by twenty feet in horizontal dimensions and thirty-five to forty feet high, has been reached by movement occurring since glacial times, then the distance travelled might conceivably be enough to be detected in fifty years. Using the smaller number of years suggested by Flint for a locality in Wisconsin, for the time of a lobal advance 11,500 years ago, a block moving uniformly would traverse about an inch-and-a-half in fifty years if its total movement were a conservative ten yards.

In itself, a mere inch-and-a-half would seem to be undetectable in photographs. But in close-up *stereo*-photographs such a slight shift need not exact from the observer so great an allowance for error of estimation. This is understandable when one realizes that stero-photographs permit the alignment of an infinite number of points. When many alignments can be made, particularly with the accountable object very close to the camera, and there is an almost perfect alignment in every

direction matched visually on the spot, it is safe to conclude that movement of as little as an inch would bring distant objects *into* view which are not in view on the photographs, or, at the other extreme, *obscure* presently visible objects in the background. The maximum lateral movement of the block studied intensively would produce an eclipse or a revelation of about ten inches on the background rock face twenty-five feet away, with the edge of the block forming the interception three-and-a-half feet from the camera. One such block appeared on the stereo-photographs.

There is the possibility that the block in question moved directly toward the point from which the picture was taken. There is also the possibility that the background rock moved concomittantly precisely the right distance to cancel the eclipsing or revealing effect. Both these possibilities prevent one from stating flatly that in fifty years, more or less, there has been *no* motion of the block under study. In any case, the alignments are extraordinarily clear, and afford a convincing proof that whatever movement has accomplished the scattering of the blocks it has taken much longer than "probably a few hundred years or at most a few thousand."

"*Gold Hunters' Cave.*"—A wide-mouthed cave (called "Gold Hunters' Cave" because iron pyrites once lured the uninitiated to the spot), extending under the thick layer of solid conglomerate to a depth of about thirty feet, has been a prominent attraction for many decades and consequently appears in several of the old photographs. A cascade descends over the lip of the cave. Its waters soon enter a man-made pond and then flow north as part of the St. Lawrence drainage system. Pictures were taken from within the cave, looking out of the lenticular opening, and also from outside from a point on the path slightly above the entrance; the angle from outside affords an additional helpful perspective for angular studies. Here again an unexpected changless picture is seen. The rocks at the entrance, with one minor exception, are as before. The exception is a slab about eight inches thick and roughly eight square feet in area, lying on a large block in one piece in the photograph taken from within the cave; the same piece is now broken cleanly in two through the middle vertically, and the two pieces are still in view close together in the original position.

Another observable similarity between the photographs and present conditions is the texture of the rock surfaces upon which the cascade has been falling gently for many years. (Recent quarrying operations to the west have cut off the small creek furnishing water to the cascade. In 1955, the writer and the late Mr. Perry Green of Mantua Corners, a man with legislative experience and influence, became interested in endeavoring to have the owners of the quarry reroute the stream to maintain the scenic cascade, but without success. Mr. Green, it should be mentioned, is the individual whose efforts in the interests of conservation and the public domaine led the State Legislature to set aside the Ledges as a State Park, and it is to him, therefore, that the thousands of people using the Park each summer are unknowingly indebted.) If one is accustomed to taking adages at their face value, here is a rock face which denies the adage. A rough estimate of stream flow would place the spring thaw descent at fifty to sixty gallons per minute, and for more than half the year over ten gallons per minute would be a conservative figure. In dry periods, of course, the cascade would have been a mere trickle. A spring at the base of the Sharon about one hundred yards to the south from which the inn draws its supply is said to flow adequately even in the driest years when others in the township fail. The unchanged surface of the rocks at the foot of the cascade, under constant attack as it were, is remarkably out of keeping with what one would expect.

A large log two feet in diameter, believed to be an American chestnut, also lies in the direct path of the former cascade. The same log, exactly in the same position, appears in the photographs fifty or more years old. Not the slightest

alteration of its physical state can be seen. The low temperature, seldom if ever rising above 60° F, has probably greatly favored preservation.

The floor of the cave, however, has changed appreciably. Debris, consisting mainly of iron-oxide-reddened clay from decomposed shale, has accumulated so that the cave floor is approximately eighteen inches higher than it was. Several explanations are suggested. Fragments from the soft, underlying layer of shale outcropping on the back wall of the cave (Meadville or possibly Orangeville —the old Mississipian hilltops meet the Sharon with irregular disconformity in this area) (Williams, 1940), plus a small quantity of the Sharon itself, flaking off from the roof, may have blocked the exit of spring and seepage water, thereby permitting debris to remain longer than in previous times. Increased "human erosion," resulting from greatly swelled traffic by visitors to the cave and their natural curiosity in hunting for fossils in the friable shale, has doubtless contributed debris at a more rapid rate than in past decades. In any case, the elevation of the cave floor is the sole evidence of geologic change within the wide scope of the photographs which are clear and sharp.

Additional, interesting comparisons are worthy of mention.

Vegetation.—The vegetation has changed so completely that a majority of the photographs defied orientation if unique surfaces of rocks did not appear in them; and unique surfaces, when dealing with distant views, were difficult to identify. The alteration of vegetation might easily be termed absolute in identified pictures; this is with reference to trees and shrubs. A great many unidentified pictures, indeed, might be suspected of being taken in glens in a different county were it not for the imprint of the name "Nelson Ledges" on them (along with a quaint subtitle on each, a fancied resemblance to an animal or some harmless (and timeless) activity of harmonious young couples walking in shaded, wooded paths).

The wedging capacity of tree roots might be expected to exert full force amid the cracks in the rocks observed here and there. Unfortunately, there were no photographs allowing comparisons of this often cited activity of plants. Roots may have played their part in widening minor cracks on a small scale, but the huge masses of conglomerate are not fair tests of the power of roots to expand cracks.

Case-hardening phenomenon. —The persistence of pebbles in exposed rock surfaces deserves brief description. Identification of the block most intensively studied was actually made by background-recognition initially; next, its silhouette confirmed its identity; lastly, the pattern of its surface verified the original impression. These steps took a matter of seconds. Upon careful observation of the rock itself, through the viewer and then visually, the remarkable fact of the persistence of the original pebbles led to the conclusion that the edge of the rock used in triangulation and alignment was virtually unchanged, and that almost every pebble in the photographs was still lodged securely in its sandstone matrix.

As mentioned previously, quarrying of the valuable pebbles and sand (the former for refractory brick) is cutting off the Ledges from the continuous layer of Sharon extending for miles to the west. If one walks to the most recently quarried conglomerate, he will discover that the pebblestone when freshly exposed is so friable that it disintegrates under blows from his boots. Proceeding southward to older portions of the quarry, one encounters harder and harder pieces left behind by the machines, or thrown up by blasts which loosen the material to be carted away. The oldest pieces are much more resistant to crushing underfoot. This leads one to the hypothesis that after exposure the characteristics of the conglomerate change. Moreover, the ancient rocks at the Ledges themselves show concentrations of iron as sulphides and oxides on the surface, flintlike in their resistance to abrasions. Without question, the hard surface of the rocks has enabled the quartz pebbles to persist almost without change, and one may speculate that solution and frost-wedging proceed at a very slow pace for the same reason.

One more observation should be included and that is the sculpturing and pitting, particularly where cross-bedding is evident. How long these indentations, some of them deep enough to receive a large banana easily, have existed in their present form is an interesting question. They are even more pronounced on the rock walls at Kennedy Ledges across the valley. A strong similarity these pits bear to some appearing at Cascade Park in Elyria, Ohio, warrants a suggested explanation and an important possible connection with the conditions giving rise to them. At Cascade Park, the pits occur at the sides of a former river channel, now high and dry above the sizable Black River. The channel was once at the brink of a falls. It has become dry by virtue of stream piracy. The side walls of the falls must have been subjected to continuous and intensive washing and abrasion by *large volumes of water*, with the less resistant grains of sandstone washing out, leaving characteristic pitting of the surface. Transferring our attention to Nelson Ledges, we observe that the pits follow the lines of fore-sets in the cross-bedding where differential conditions of deposit are evident in the graininess of alternating layers. Could it be that the pits come into being *not* from the trickles of water that seep from within these isolated remnants detached from the main aquifer, and not because of rains which occasionally strike them (a possibility which is further excluded by the fact that the pitting is equally prominent on overhanging surfaces) as would be required if the blocks had been detached *since* glacial waters ceased to flow, but rather from *large volumes of water* which bore sediments with powerful abrasive action? If torrents of water are needed to produce the pitting, then the blocks may well have assumed their present positions at the time the glaciers were melting and receding. A quality of *changelessness* thus seems to emerge as the most prominent feature of the Ledges, insofar as gross, recent alterations in topography at this locality are concerned.

CONCLUSIONS

The combination of evidence and deduction lends credence to the theory that the massive blocks of conglomerate at Nelson Ledges State Park have changed very little either in position or configuration in the thousands of years since the melting of glacial ice in the Wisconsin ice age.

The quality of changelessness may here be held before students, to offset the impressions they may erroneously gain from seeing spectacular and dramatic geologic activity elsewhere.

The value of this locality is enhanced for instructional purposes by having available some objective evidence favoring lack of change in the form of stereophotographs which may readily be copied for these purposes.

From information of this sort, adapted to the level of understanding of classes visiting this spot, the education of the very young and secondary school students in matters of deductive logic (at an age scientific attitudes are very likely developing), as well as the testing of logical mental processes among college geology students, may be advanced.

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ANTHOCYANIN PIGMENTS OF BUCKWHEAT HYPOCOTYLS

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INTRODUCTION

Although seedlings of buckwheat (*Fagopyrum sagittatum* Gilib.) have frequently been employed in studies on anthocyanin formation, the nature of the pigment or pigments involved has not been completely elucidated. Karstens (1939) offers strong evidence that the aglycon is cyanidin, but anomalous results prevented him from reaching definite conclusions concerning the identity of the glycosidal pigment. The probable cause of this uncertainty is suggested by new studies on buckwheat hypocotyls: paper-chromatographic techniques (Bate-Smith, 1949) now indicate that actually several pigments are present in this material.

METHODS

Extracts were prepared from the red hypocotyls of Japanese buckwheat seedlings 7 to 10 days old and from stems and hypocotyls of mature field-grown plants by steeping the material for several days in 1 percent hydrochloric acid in methanol or by macerating it in the same solvent. Such solutions are designated "unhydrolyzed." Some extracts were hydrolyzed by adding equal volumes of concentrated hydrochloric acid, boiling for 10 minutes, and shaking with *n*-amyl alcohol; the amyl alcohol layers were taken as the "hydrolyzed" extracts.

Portions of the solutions to be analyzed were applied to sheets of Whatman No. 1 filter paper and the resulting chromatograms developed with various solvents—usually in two dimensions, sometimes in one. Color reactions of the spots on completed chromatograms were noted. For all of the substances mentioned in this report these were as follows: untreated, pink; with ammonia vapor, blue; after spraying with 1 percent aluminum chloride solution, violet.

RESULTS AND DISCUSSION

Results obtained with extracts of seedlings and of mature plants were identical. Representative R_f values of the substances observed are presented in table 1. In every "unhydrolyzed" extract examined three pigments (here designated "A," "B," and "C") were seen provided suitable solvent systems were employed. Substance A was the principal component; substance B occurred in lesser amounts; and substance C was present in small but significant quantities. In the organic ("acid-poor") phases of the alcoholic solvents used the color of substance C faded gradually during development of the chromatograms and eventually disappeared. In these cases the final location of this pigment could not be ascertained. In "hydrolyzed" extracts only one anthocyanidin spot was noted. Significantly, this substance was also disposed to lose color in some solvents, and its R_f values closely resembled those of substance C.

Since the only method of separation which has been effective so far is that of paper chromatography, only minute amounts of these pigments have been available and the usual chemical studies have not yet been made. However, the absorption spectra of the individual pigment zones in the wavelength region 340 to 600 mμ could be measured directly from chromatograms in a Beckman DU spectrophotometer (Bradfield and Flood, 1952; Troyer, 1955). The spectra thus obtained resemble those usually reported for anthocyanins. Locations of the principal absorption maxima are given in table 1. Spectra of substance C

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and the anthocyanidin from a "hydrolyzed" extract were almost exactly the same and different from those of substances A and B. Since substance A was present in larger quantities, some of this material was eluted from chromatograms with acid ethanol and the spectrum of the solution measured. The latter closely resembled that taken from filter paper.

It seems likely that substance C and the anthocyanidin in "hydrolyzed" extracts are identical. In order to check the possibility that the appearance of substance C may have resulted from hydrolysis during the extraction procedure, additional "unhydrolyzed" extracts were prepared at low temperatures with immediate preparation of the chromatograms. In all cases significant amounts of substance C were found.

The anthocyanin pattern in buckwheat is thus more complex than has been supposed. Under usual conditions the hypocotyl contains at least three pigments. One of these is an anthocyanidin, presumably cyanidin (Karstens, 1939). The other two are anthocyanin derivatives of the first. Obviously any study of conditions influencing anthocyanin formation in this plant should embrace a consideration of possible changes in each of the several constituents.

TABLE 1

R_f values and absorption maxima of anthocyanin pigments in extracts of buckwheat hypocotyls. Solvent composition designated by volume

SOLVENT	PIGMENTS IN UNHYDROLYZED EXTRACT			ANTHOCYANIDIN IN HYDROLYZED EXTRACT
	A	B	C	
n–Butanol–2N HCl (1–1) (upper)	.30	.27	—	.85
n–Butanol–2N HCl (1–1) (lower)	.33	.16	.06	.07
n–Amyl Alc.–2N HCl (1–1) (upper)	.08	.10	—	—
n–Amyl Alc.–2N HCl (1–1) (lower)	.30	.14	.06	.07
n–Octanol–2N HCl (1–1) (upper)	.07	.06	—	—
n–Octanol–2N HCl (1–1) (lower)	.18	.08	.04	.06
Acetic Acid–2N HCl (6–4)	.80	.70	.52	.52
Propionic Acid–2N HCl (6–4)	.81	.65	.57	.60
Absorption maximum on filter paper, wavelength in mμ	535–540	535–538	543–545	543–545

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A COMPARISON OF WINTERING BIRD POPULATIONS IN THREE OPEN FIELD TYPES IN CENTRAL OHIO

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INTRODUCTION

The study of wintering bird populations is still a relatively unexplored field. Although a large number of censuses are available for some habitats, many important habitats and geographical areas remain unknown. Few studies have been made of winter bird populations in open field areas. Forbes and Gross (1921) surveyed bird populations in open fields in Illinois by means of a strip census method and summarized their results according to field type and the general section of the state. Since then, few extensive studies have been made. In recent years the Winter Bird-population Studies sponsored by the National Audubon Society have increased interest in this phase of ornithology.

A number of factors has limited the usefulness of many of these more recent studies in determining average populations for various field types. Many censuses have covered more than one field type without separating the data for the various types. Inadequate descriptions of single field types have also made comparisons difficult. Often no distinction has been made between edge species, the populations of which are not directly related to the field size, and true open field species.

In the present study the author has attempted to eliminate some of these difficulties and to determine average populations of certain field types. These data represent, however, only a preliminary step in this direction.

PROCEDURE

The following three types of fields were chosen for the study:

1. Undisturbed corn stubble.—Corn fields of this type had been harvested with a mechanical corn picker, which left the entire stalks rooted in the original rows, their upper parts bent over at a uniform height of one to one and one-half feet and lying parallel to the rows. Waste corn was abundant. These fields had not been otherwise disturbed.

2. Disked corn stubble.—Corn in this type had been harvested in a manner similar to that of the previous type; but following the harvesting, the field had been harrowed or disked and winter grain planted. This resulted in the uprooting and cutting up of the corn stalks, thereby eliminating much of the cover which had been present. The general appearance was that of a nearly bare field with scattered debris of corn stalks and short basal stubs sticking up at wide intervals. Much of the waste corn was still available. The winter grain had grown to a height of only 1 to 2 inches, in rows about eight inches apart.

3. Soybean stubble.—In this type the soybeans had been cut, leaving stubble 2 to 5 inches high, with occasional small mats of soybean stems. The general appearance was that of an almost bare field. In two of the fields, #11 and #12 (table 1), winter grain had been planted following the cutting of the soybeans. Although this had resulted in some disturbance of the ground, much of the stubble still remained, and this, along with soybean debris, still dominated the appearance of the fields.

These fields were located in Oxford, Troy, Radnor, and Marlboro Townships in north-central Delaware County, Ohio. The approximate sizes of the fields were obtained by pacing the sides and calculating the area from these measurements. Areas obtained in this manner ranged from 12 to 30 acres. Fields of undisturbed corn stubble were numbered from 1 to 5, and in size were respectively 25, 30, 20,

17, and 13 acres. Those of disked corn stubble, numbered 6 through 10, were respectively 29, 20, 12, 12, and 27 acres in size. Soybean stubble fields, numbered 11 through 15, were 24, 28, 14, 24, and 25 acres in size, respectively.

Bird populations of the fields were determined by a series of six census trips through each field. These trips varied from 10 to 30 minutes in length, depending upon the size of the field, its type, and the number of birds present. Censusing was carried out during two periods, December 25 to 28, 1956, and January 29 to February 2, 1957. Three trips were taken through each of the fields during each of these periods.

TABLE 1

Winter populations (birds per 100 acres) of open field birds in 15 fields of three types in Delaware County, Ohio, during the winter of 1956–57

Species	Undisturbed corn stubble					Disked corn stubble					Soybean stubble				
Field No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Size in acres	25	30	20	17	13	29	20	12	12	27	24	28	14	24	25
Cooper's Hawk (*Accipiter cooperi*)		1													
Red-tailed Hawk (*Buteo jamaicensis*)	1		1						+	1				1	+
Marsh Hawk (*Circus cyaneus*)	+	+	1	1	2	+	1				+	1	1		
Sparrow Hawk (*Falco sparverius*)				1											
Bob-white (*Colinus virginianus*)		7		26											
Ring-necked Pheasant (*Phasianus colchicus*)		7													
Mourning Dove (*Zenaidura macroura*)	12	84	9	162	95	1	1								
Short-eared Owl (*Asio flammeus*)		1				+					+				
Horned Lark (*Eremophila alpestris*)	24	1	39	3	81	180	296	1	243	58	26	4	15	4	2
Starling (*Sturnus vulgaris*)						2									
Eastern Meadowlark (*Sturnella magna*)				1	1		48								
Lapland Longspur (*Calcarius lapponicus*)						19	95		35	12	35				
Snow Bunting (*Plectrophenax nivalis*)										4					
Total	37	101	50	194	180	200	443	1	278	75	61	5	16	5	2

Only permanent residents of open fields or species which utilized the fields apparently independently of the edge during daytime feeding were considered in the census. Birds of prey flying over the area were assumed to be foraging and were included. Other species merely flying over were excluded.

In many cases it was necessary to estimate large flocks of birds, resulting in the introduction of some error in the final population figures.

The average population per 100 acres for each of the 15 fields was calculated from the size of the field and the results of the six census trips (table 1). The average population per 100 acres for each type was calculated from the data for

the five fields of that type (table 2). Figures were rounded to the nearest whole number. Where the average population was less than 0.5 birds per 100 acres, or where the species was recorded at times other than census trips, a + was used to indicate presence only (tables 1 and 2). A frequency index was calculated for each species in each of the three types by dividing the number of occurances of the species on individual census trips in all five fields of the same type by the number of possible occurances (table 2).

TABLE 2

A comparison of the populations of open field birds (average numbers per 100 acres) in three types of open field areas in Delaware County, Ohio, during the winter of 1956–57

Species	Undisturbed corn stubble		Disked corn stubble		Soybean stubble	
	ave. pop.	freq. index	ave. pop.	freq. index	ave. pop.	freq. index
Cooper's Hawk (*Accipiter cooperi*)	+	.03				
Red-tailed Hawk (*Buteo jamaicensis*)	+	.10	+	.03	+	.03
Marsh Hawk (*Circus cyaneus*)	1	.13	+	.03	+	.07
Sparrow Hawk (*Falco sparverius*)	+	.03				
Bob-white (*Colinus virginianus*)	6	.07				
Ring-necked Pheasant (*Phasianus colchicus*)	2	.03				
Mourning Dove (*Zenaidura macroura*)	70	.53	1	.07		
Short-eared Owl (*Asio flammeus*)	+	.07	+	.00	+	.00
Horned Lark (*Eremophila alpestris*)	24	.43	156	.73	10	.30
Starling (*Sturnus vulgaris*)			+	.03		
Eastern Meadowlark (*Sturnella magna*)	+	.07	10	.17		
Lapland Longspur (*Calcarius lapponicus*)			32	.40	7	.03
Snow Bunting (*Plectrophenax nivalis*)			1	.07		
Total	103		200		17	

RESULTS AND DISCUSSION

The total population was found to be highest in the disked corn stubble type, where 200 birds per 100 acres were found, and second highest in the undisturbed corn stubble, where 103 birds per 100 acres were found. Only 17 birds per 100 acres were found in the soybean stubble (table 2).

The nature of the populations from which the samples were taken makes statistical interpretation of these differences difficult, but the high apparent differences in many cases suggest that they are real.

The difference between populations in the disked corn stubble and the soybean stubble is emphasized by the fact that in three cases fields of the two types were adjacent to each other. These three pairs of adjacent fields were #6 and #11, #7 and #13, and #10 and #15 (table 1). For these three disked corn stubble fields

the average population per 100 acres was 220 birds while for the three soybean stubble fields the population was only 28 birds per 100 acres. Since these adjacent fields were readily accessible to the same groups of birds, this difference seems to indicate a definite preference for the disked corn stubble.

Among the individual fields of the same type, there was a high degree of variation in total population and populations of individual species (table 1); *e.g.*, in the disked corn stubble total populations per 100 acres varied from 1 to 443 birds. The causes of these variations were not investigated. Some variation may have been due to minor differences between the fields themselves. In addition, since many of the species involved are wide ranging in their winter activities, differences may also have been due to characteristics of the surrounding areas which were not always apparent from examination of the fields themselves.

Populations of Horned Larks and Mourning Doves showed marked differences between the three field types. The former had populations, in birds per 100 acres, of 156 in disked corn stubble, 24 in undisturbed corn stubble, and 10 in soybean stubble (table 2). The high population in disked corn stubble seemed to be due to a combination of available waste corn and absence of much cover. The birds were observed feeding on the corn and, at times when light snow covered the ground, tracks of the birds formed radiating lines to corn ears from which much of the corn had been removed. The Mourning Dove showed the highest population in the undisturbed corn stubble, 70 birds per 100 acres (table 2). The high population of this species seemed to be related to the presence of waste corn and the cover provided by the basal parts of the corn stalks.

Two other typical open field birds, the Lapland Longspur and the Snow Bunting, the latter in small numbers in one field only, showed preferences similar to those of the Horned Lark. Bob-white and Ring-necked Pheasant, on the other hand, appeared only in fields of the undisturbed corn stubble (table 2).

The population figure of 10 birds per 100 acres for Horned Larks in the soybean stubble fields (table 2) may not represent true winter density. On trips during the period from January 29 to February 2, territorial males and pairs of this species were encountered in these fields where none were found during the first series of census trips. Future winter studies involving this species should probably be concluded at an earlier date, if the objective of such a study is to determine the relation of the bird to the winter food supply of the species.

Population figures calculated for the first three trips through each field, taken between December 25 and 28, and the last three, taken between January 29 and February 2, often gave considerably different results. This would seem to indicate that the winter population of the species under consideration was not a stable one. Horned Larks and Mourning Doves showed lower densities and Lapland Longspurs higher densities during the second series of census trips than during the first series.

SUMMARY

Because of the existing lack of information on wintering populations of open field birds, the author attempted to obtain accurate data in this regard by censusing five fields each of disked corn stubble, undisturbed corn stubble, and soybean stubble, ranging in size from 12 to 30 acres, and located in Delaware County, Ohio.

Open field species were censused on six occasions during the periods from December 25 to 28, 1956, and January 29 to February 2, 1957.

Total populations were found to be highest in the disked corn stubble, second highest in the undisturbed corn stubble, and lowest in the soybean stubble.

Considerable variation in both total population and populations of individual species occurred within the fields of the same type.

Horned Larks showed the highest populations in disked corn stubble, seemingly because of availability of waste corn and absence of cover. Lapland Longspurs and Snow Buntings showed similar preferences.

Mourning Doves were most abundant in undisturbed corn stubble, possibly related to the presence of waste corn and cover. Bob-white and Ring-necked Pheasant showed similar preferences.

Censuses involving Horned Larks should be concluded at an early date since these birds become territorial by late January.

Differences in population densities for individual species between the two census periods indicate that winter populations of some species are very unstable.

ACKNOWLEDGMENTS

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Flotation. *A. M. Gaudin.* McGraw-Hill Book Company, Inc., New York. Second edition, 1957. ix+573 pp. $12.50.

The second edition of this book incorporates the most recent contributions to the art of flotation. A detailed scientific analysis of the separation of dissimilar solid particles by selective water-repellancy of their surfaces is made. The principles of surface chemistry and their application to problems of mineral beneficiation are given an extensive treatment. Fluid mechanics is applied to the movement of fine solid particles and gas bubbles through liquids. The industrial applications of the flotation process are covered in considerable detail. The author has succeeded in presenting an excellent scientific and engineering analysis of the flotation process. Unsolved problems, controversial issues, and current and planned reserach are covered. The treatment is too advanced for the average undergraduate engineer; however, it is recommended as a text for graduate students specializing in Mining Engineering, Mineral Dressing, or Metallurgical Engineering. It should be a reference book for all scientists and engineers concerned with mineral beneficiation.

GEORGE R. ST. PIERRE

Geologic Field Methods. *Julian W. Low.* Harper & Brothers, Publishers, New York. 1957. xv + 489 pp., 214 figs., 11 tables. Professional edition $6.00; Text edition $4.50.

All who know of Mr. Low's excellent manual, *Plane Table Mapping*, will welcome this companion volume, in the preparation of which both the author and the publisher have exercised the same careful attention to content and details of presentation that made the earlier book so famous. Mr. Low has followed a sound philosophy in determining the organization and content of this book. It is not a manual or compendium of geology, but is a manual of effective and reliable field methods. It is designed to help either student or practicing geologists to gather data that will constitute a sound basis for laboratory work and analysis and interpretation in the office. In its details it is encyclopedic. Major topics included, by chapters, are 1) Introduction to surface geological investigations; 2) Organization of field work; 3) Living and working out of doors; 4) Field mapping; 5) Topography and areal geology; 6) Structural field work; 7) Stratigraphic field work; 8) Mineral exploration; 9) Subsurface methods; and 10) Geologic illustrations. Chapter 4 is apparently condensed from parts of Chapters 2 and 3 of the earlier work. However, the two works are clearly complementary and neither is in any sense a substitute for the other.

The professional edition is printed on slightly better paper and has a water-resistant cover; nevertheless, the text edition is of virtually the same quality.

MALCOLM P. WEISS

Reason and Chance in Scientific Discovery. *R. Taton* (Translated by A. J. Pomerans) Philosophical Library, Inc., New York, 1957. 171 pp. $10.00.

This is a most refreshing series of philosophical essays and anecdotes on discoveries accomplished by some famous scientists. Excepting page 163, the term "research" is conspicuously rare, and thus is consistent with the truism: The people who say the most about "research" are the ones who know the least about it.

The author's popularity will not be very great among persons who believe that "push-button research" can be "augmented, expedited and integrated" through "team (group effort" and "brainstorming (idea) sessions" by "pressurizing" individuals who are not competent in the first place. The book contains recurrent evidence of individual ingenuity, coupled with the inference that all men are not endowed with inherent ability and no amount of schooling can give it to them.

The book is divided into three parts: (1) the different domains of discovery, (2) the factors involved in discovery, and (3) the various aspects of discovery. The 32 plates add to an attractive format, but the price, unfortunately, may reduce its circulation.

DUNCAN MCCONNELL

Atomic Energy in Agriculture. *William E. Dick.* Philosophical Library, Inc., New York. 1957. xi + 150 pp. $6.00.

The voluminous literature on atomic energy often immeshes the ordinary individual who is interested in current scientific progress in a maze of technical details. It is gratifying to encounter a book such as this where the basic research in a particular area has been abstracted and is presented to the reader along with only such pertinent data as are necessary for clarity. Mostly it is a synopsis of the reports at the 1955 Geneva Conference on peaceful uses of atomic energy. There is no note of finality, but rather an attempt to show the various and peculiar ways in which atomic energy is emerging as a useful tool in agriculture with all its ramifications. The brief historical aspects of the various problems merely serve to illuminate the significance of the recent advances. The chapters that deal with radiation effects on genetics, pest control and food preservation are intriguing in the light of predicted, future agricultural economics. Problems exposed in these areas and in forestry, merit examination by the agricultural researcher because many require final solution. Two chapters on tracer work in photosynthesis and mineral movements in the plant complete this reference work.

CLARENCE E. TAFT

BOOKS RECEIVED BY BOOK REVIEW EDITOR FOR NOTICE OR REVIEW

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1/ 2/57 THE LEIBNIZ-CLARKE CORRESPONDENCE. H. G. Alexander, Editor. Philosophical Library, N. Y. 1956. lvi+200 pp. $4.75.

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4/30/57 INTRODUCTION TO CHEMISTRY. Joseph C. Muhler, Charles S. Rohrer, and Ernest E. Campaine. Prentice-Hall, Inc., Englewood Cliffs, N. Y. viii+452 pp. $6.75.

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